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PHYSICAL AND MEDICAL

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GEOLOGICAL AND MINING

SURVEY

THE DUBLIN SOCIETY
OF THE

CONNAUGHT COAL DISTRICT

*laying to rest the long and laborious
Mining Report of the Connaught Coal Dis-
trict, together with a Map and Section
of the district.*
IN IRELAND.

In perusing the Report you will find
BY RICHARD GRIFFITH, JUN. ESQ.

**INSPECTOR GENERAL OF HIS MAJESTY'S ROYAL MINES IN
IRELAND, MINING ENGINEER TO THE DUBLIN SOCIETY,
F. R. S. EDINBURGH, &c. &c. &c.**

*I have also the honor to have the
respecting the Antrim Iron Works, in the
County of Down, showing their pro-
perty in the County of the Antrim*
DUBLIN:

**GRAISBERRY AND CAMPBELL, 10, BACK-LANE,
PRINTERS TO THE DUBLIN SOCIETY.**

1818.

*1818-1819
No. 10, Back Lane
Dublin*

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PRINTED TO THE DUBLIN SOCIETY.

1818.

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München

TO THE

RIGHT HONORABLE AND HONORABLE

THE DUBLIN SOCIETY.

MY LORDS AND GENTLEMEN,

HEREWITH I have the honor of laying before you my Geological and Mining Report of the Connaught Coal District, together with a Map and Section of the district.

In perusing the Report you will find, that the country contains abundance of bituminous Coal of excellent quality, which, from various causes, remains neglected and unwrought.

I have also entered into some detail respecting the Arigna Iron Works, in the county of Roscommon, shewing their peculiarly favorable situation, the cheapness and superior quality of all the requisite ingredients for smelting Iron, and assigning the true causes of the failure of the works.

I hope the whole will prove acceptable to you, and beneficial to the Mines and Manufactures of Ireland.

I have the honor to be,

My Lords and Gentlemen,

Your most obedient

Humble servant,

RICHARD GRIFFITH, JUN.

Mining Engineer to the Dublin Society.

Dublin Society House,

April 24, 1818.

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ADVERTISEMENT.

THE following Report on the Connaught Coal District is intended as a Supplement to the Report on the Leinster Coal District, already published. To avoid repetition, frequent reference is made both to the text and plates contained in the Report on the Leinster Coal District, particularly to those which exhibit the different methods of working coal, as practised in England.

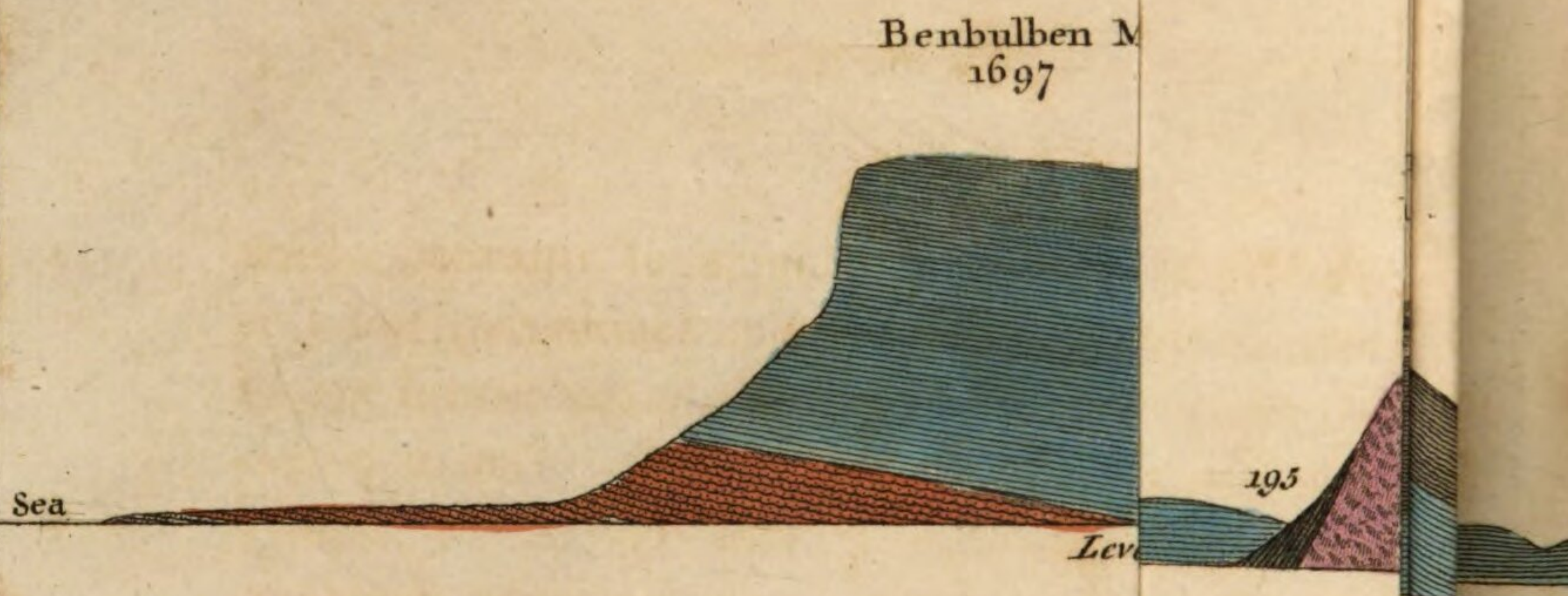
ADVERTISEMENT

The following Report on the Cornish Coal District is intended as a supplement to the Report on the Llanerco Coal District, already published. To avoid repetition, reference is made both to the text and plates contained in the Report on the Llanerco Coal District, particularly to those which exhibit the different methods of working coal, as practiced in England.

Explanation of the colours



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Note The figures denote the height in feet above the Level

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trict contains only simple carbonaceous, or
non-flaming coal. The object of our present
survey is to ascertain the extent of the coal
fields in the north-west of Ireland, which has received
the name of the Connaught coal district.

GEOLOGICAL AND MINING SURVEY OF THE CONNAUGHT COAL DISTRICT.

AMONG the many objects of interest, which
attract the attention of the Geologist, none is
more worthy of pursuit than the useful art of
discovering and tracing mines. But it unfor-
tunately happens, that this species of inquiry
offers less variety to the scientific observer,
than the more general investigation of the great
field of nature; and it has in consequence been
usually left to the guidance of mere practical
miners, who are wholly unacquainted with the
general relations and arrangement of rocks.

Mining, as a science, is nearly unknown in
this country; and our mineral resources, under
the guidance of chance and ignorance, have only

led to the impoverishment and disappointment of those, who have endeavoured to develope them. Under these circumstances the discovery of coal mines, being the most necessary and directly useful, claims our first attention.

In the Report on the “ Leinster coal district,” lately published, the situations of the principal coal fields of Ireland have been mentioned; it is unnecessary, therefore, to repeat them in this place. The Leinster coal district contains only simple carbonaceous, or non-flaming coal. The object of our present inquiry shall be the *inflammable* coal district of the north-west of Ireland, which has received the name of the Connaught coal district.

This district occupies considerable portions of the counties of Roscommon, Sligo, and Leitrim, in the province of Connaught, and part of the county of Cavan, in the province of Ulster.

Lough Allen, situated near the head of the river Shannon, forms a bason in the centre of the district; and when the navigation of the Shannon shall have been completed, it will afford a cheap and easy communication with the interior of Ireland, the city of Limerick, and, by means of the Grand and Royal canals, with the city of Dublin. It will be proved in the progress of this report, that the Connaught coal district contains extensive tracts of coal of excellent quality. Nothing then is wanting but perseverance, united with judgment in working them, to supply the steady and ample markets,

which this union of navigations will open for its consumption.

But, previous to entering into the description and detail of the Connaught coal district, it may be useful to give a brief sketch of the geological position of that district, with respect to the neighbouring country, and to suggest to landed proprietors the kind of mines or other valuable mineral substance, which is likely to be found in the different species of rocks that occur in the country. It is time that it should be known that no coal is likely to be met with in the *graywacké*,* or limestone districts of the north-west of Ireland, and that we should no longer hear of, and witness useless trials for coal being commenced and persevered in at the instigation of ignorant or designing miners. There is no real scarcity of coal in Ireland; but unfortunately more money has been fruitlessly expended in searching for coal, where none was likely to be found, than in those situations, where, if sought for with judgment, there is little doubt of its being discovered.

The relative positions of the different rocks, that occur in the country, will be seen at once

* In this work Professor Werner's names and classification of rocks will be adopted, as those in general use, but without any reference to theoretical speculation.

All mineralogical or geological terms, or terms of art, will be found explained in the glossary. See appendix, No. 3.

by reference to the geological section, which accompanies this Report.

The elevations above the sea, as given in the section, were ascertained by observations carefully made with one of Troughton's large barometers, and calculated according to the Formula of La Place; and the distances between the different points were taken from county maps on a large scale.

The range of primary mountains, which extend from Foxford, in the county of Mayo, to Colooney, in the county of Sligo, and end two miles to the north-east of Manor Hamilton, may be said to form the base of the strata of that part of the north-west of Ireland. Upon this base rests the *first or old floetz sandstone*, which is succeeded by the *first floetz limestone*; and this again by the series of rocks which accompany coal. This series forms the uppermost strata in the country.

This range of primary mountains is, for the most part, composed of *mica slate*; but in some places the whole suite of primary rocks may be observed. This is particularly the case at Benbo mountain, near Manor Hamilton.—The elevation of this mountain above the sea * is 1403

* This elevation was ascertained by a chain of barometrical observations, made with *one* of Troughton's large barometers. First, by an observation at the sea at Sligo harbour, and secondly, on the same day, at a station in Manor Hamilton. The height of the summit of Benbo mountain above Manor

feet. The summit, and about eight hundred feet immediately below it, are composed of a fine grained *granite*, having the appearance of *gneiss*, from the arrangement of the *mica* in one direction; but there is no appearance of stratification. The granite is covered on both sides of the mountain by a stratified *micaceous quartz rock*, dipping in the direction of its declivity at an angle of 50° from the horizon. At the base of the mountain a great variety of rocks is visible, *hornblende rock*, *hornblende slate*, and mica slate, with a profusion of garnets. Large masses of a beautiful Syenite, with green *hornblende*; also serpentine and green Steatite, thickly studded with precious garnets, were found in a stream at the base of the mountain, next to Lurganboy. Probably these rocks and many others occur in *Situ*, in a minor mountain situated between Benbo and Lurganboy, as they are to be found in all the walls of the neighbourhood. On the western base of Benbo mountain some of these rocks are found much decomposed, and clays of various colours are met with, as red, yellow, black, and bluish white. Of the last, considerable quantities have been raised, and used instead of fuller's earth in washing floors. It feels soapy, and

Hamilton was ascertained some days after by the mean of two observations taken at Manor Hamilton, one in the morning, and another in the evening of the same day; and the observations on Benbo were made in the middle of the same day.

resembles decomposed steatite. Large masses of sulphur pyrites are found amongst it. The pits were so closed up, that it was not possible to determine the relations of this steatitic clay with the stratification of the mountain. Possibly it may belong to a vein of steatite.

The western base of Benbo mountain is traversed by a metallic vein, containing copper pyrites. It was formerly wrought, though apparently to no great extent. Some of the shafts and levels are still visible. The vein runs in a north-east and south-west direction, from the base of Benbo mountain, across the limestone strata,* which cover the primary country between Benbo and the village of Lurganboy. It is remarkable that sulphuret of lead, and no copper, was found in the workings on the vein, which were made in the limestone country on the lands of Shanna, a quarter of a mile to the south of Lurganboy. This vein has been worked in many places between Shanna and the workings at the base of Benbo mountain; and some of the excavations are so large, that the vein must have been both rich and very wide to defray the expence, which must have been incurred. The difficulty of freeing the mine from water, at a time when mining machinery

* In this particular direction the old sandstone, which is generally interposed between the primary rocks and the limestone, is wanting; though it occurs in its usual place, immediately to the south of the line of the vein.

was almost unknown, has apparently been the cause of its abandonment. The workings on the copper part of the vein have been discontinued for sixty years, but the lead mine of Shanna was partially wrought twenty years ago.*

The range of primary mountains, which extend from Foxford to Manor Hamilton, are very narrow. They rarely exceed three miles in breadth, and at some places, as at Colooney, are not a quarter of a mile broad. They are in general succeeded by beds of red, grey, or yellowish white sandstone, belonging to the first or oldest floetz sandstone formation; and, when this rock is wanting, by limestone. The sandstone formation is apparently of very unequal thickness, and very irregular in its stratification. In some places it forms lofty hills, and even ranges of mountains; and at others it does not exceed twenty or thirty feet in thickness. It is sometimes, though rarely, interstratified with a reddish or greyish sandstone slate. Where this happens, it has been mistaken for sandstone of the coal formation; and many fruitless trials for coal have been made in consequence. The hill of Fairymount, in the county of Roscommon, situated to the south of Strokestown, has been supposed to contain coal; as also the hill of Ballyfermoyle, situated to the north-east of Lough Key, and close to the coal country.

* This information was received from a very old man, who said he had wrought in all the workings.

It is, however, separated from it by a succession of beds of limestone, exceeding one thousand feet in thickness, which rest upon the old sandstone, and run under the rocks which belong to the coal formation.

It would be tedious and unnecessary to mention all the places, where strata belonging to the first floetz sandstone formation occur in the vicinity of the Connaught coal district, rising in insulated hills from beneath the limestone. It may be sufficient to observe, as a distinguishing mark between the old floetz sandstone and the sandstone of the coal formation, that the first always lies below, and the second above the first floetz limestone.

OF THE LIMESTONE COUNTRY.

The limestone strata, which surround the Connaught coal district, form a part of the great limestone district of Ireland, which extends, with little interruption, in an east and west direction from Galway to Dublin; and from Clonmel to Enniskillen in a north and south direction.

The aspect and quality of the limestone varies very much in different places; but the difference appears to arise chiefly from the position, which the beds seen at the surface hold in the general limestone series. The lower beds are usually black; they contain considerable

portions both of the siliceous and argillaceous earths, and are rarely sufficiently pure to burn into lime. They are frequently interstratified with beds of black slate clay. This impure limestone has received the name of calp from Mr. Kirwan. Calp occurs in great abundance in the neighbourhood of Dublin, from whence it extends into the county of Meath. It is also met with in various parts of the counties of Longford and Cavan, particularly where the limestone approaches the upper beds of the old or first floetz* sandstone. In the neighbourhood of Granard and Edgeworthstown, in addition to the beds of black slate clay, the calp strata is accompanied by thin layers of *lydian stone*, which are sometimes so numerous, as to give the rock a very unusual striped appearance.

In the northern part of the county of Roscommon, near to Boyle and Castle Tenison, there is a remarkable variation in the lower beds of the limestone; for, even where they are found in contact with a substratum of sandstone, the limestone is quite pure, of a light grey colour, and highly chrystalline structure, so much so

* Many fruitless trials have been made in search of coal in different parts of the calp country by ignorant miners, who mistook the black slate clay, with which it is interstratified, for the slate clay which forms a principal member in the coal series. Some additional remarks on the subject, and other supposed indications of coal, will be found in the introduction to the Report on the Leinster coal district.

as to be susceptible of a very high polish. At Knockcranny, near Castle Tenison, there is a very fine quarry of this variety of limestone; and beautiful grey marble chimney pieces have been made from solid blocks of stone raised from it.

The calp beds are usually succeeded by strata of black limestone, having a chrystalline structure. Of this species we have examples in the black marbles of Kilkenny, Limerick, Galway, Westport, and numberless other places. These marbles are exactly similar to the grey marble of Knockcranny, except in the colour; and this variation is caused by an admixture of less than one per cent of carbon in the black marbles. The marble beds graduate into light greyish blue limestone, which is the usual colour of this rock. Towards the upper beds, the colour becomes light grey, and the rock contains a profusion of petrifications, but principally of madrepores, chamites, and archites.

The arrangement of the limestone series just described is very similar to that given in my Report on the Leinster coal district, in speaking of the stratification of the valley of the river Barrow, near to Carlow. But at Carlow all these varieties occur in a space of two miles, which in other parts of Ireland occupy a length of sixty or seventy. When the first description was written, I was not aware that the same arrangement was observable throughout the whole of the limestone district of Ireland.

It is remarkable, that in every part of Ireland wherever the limestone strata end, (by the rising up of the first floetz sandstone, or other rock from *beneath* them, or by their being *covered* by the strata which accompany coal,) they are found to be much disturbed and broken; and the disturbance is observed to have taken place equally, whether the bounding rock lies above or below the limestone. Numberless instances may be quoted of disturbances in both situations. Of the first, where the limestone ends by other rocks rising from beneath, perhaps the most remarkable instance occurs in the great caves and subterranean rivers at Cong in the county of Mayo: at this place the superfluous waters of Lough Mask are conveyed in a subterranean channel, until they burst forth near the village of Cong, from a circular gulph, fifty yards in diameter, and rushing with astonishing velocity along the surface for two hundred yards, descend rapidly into the earth through a second gulph, and entirely disappear; but still pursuing their secret course they ultimately fall into Lough Corrib. Perhaps the origin of the vast lakes Lough Corrib, and Lough Mask, which for their whole length form the boundary between the limestone and the inferior rocks, may be attributed to a similar disturbance on a larger scale. In many places the bed of a river or stream is found to be the precise boundary between the limestone and the rock, which lies below it. In the county of Long.

ford the river Camlin forms the boundary of the limestone and old sandstone strata, for many miles in length. Disturbances similar to those at Cong have been observed in the limestone strata near the commencement of several of the coal districts of Ireland. If we except the cave of Dunmore, in the county of Kilkenny, which is mentioned in the Report on the Leinster coal district, none is more curious than the cave called Pulgum, or the Pigeonhole, three miles to the south of Swanlinbar, in the county of Cavan. This cavern is narrow, but very lofty, and more than half a mile in length in a northern direction; in a southern direction it descends very rapidly. Its *length* was not ascertained, from the difficulty of proceeding. The lower, and many of the loose rocks which cover the bottom of the cave, are as highly polished on the surface as the most finished piece of marble. This must have been effected by the dropping of water: though water falling through the fissures of a limestone cavern usually forms calcareous stalactites from the roof, and calcareous incrustations on the sides. This is not the case at Pulgum; the difference may be attributed to the flowing of the water directly from the colliery hills into the cavern, and, meeting no limestone in the way, it is not likely to contain any thing but particles of sand and clay, the constant friction of which may have had the effect of polishing the surface of the limestone in the cavern.

There are many other remarkable caverns, and subterranean rivers along the boundary of the Connaught coal district, but it is needless to particularize them.

Whence the origin of these caves? Why are they confined to the limestone? and why do they occur so frequently in the vicinity of other rocks? These questions are difficult to resolve, but their solution would be of considerable benefit to the scientific miner, and highly interesting to the geologist.

It rarely happens, that any foreign beds occur interstratified with the limestone. At Westport, beds of sandstone occur interstratified with black limestone. Sandstone also occurs interstratified with limestone at Daly's Bridge, in the county of Cavan; and at Dunfinney Bay, in the county of Mayo, there are several alternations of black limestone, with sandstone and black slate clay. These strata are very similar to those, which occur in the metalliferous districts of Northumberland, Cumberland, Yorkshire and Derbyshire; and possibly they may contain veins of lead, though none have hitherto been discovered. Beds of sandstone have also been observed at Latt, near the town of Cavan, and in other places in that neighbourhood, interstratified with calp, and calp slate. A fruitless borehole has been made at Latt, in search of coal, and many still believe that coal may yet be found there. The sandstone, which occurs interstratified with black limestone and

calp, probably belongs to the old sandstone formation. In all the cases here mentioned the occurrence takes place close to the end of the limestone, and the commencement of primary or transition rocks. There is a precipitous hill, composed of graywacké, one hundred yards to the north of the borehole at Latt.

The strata which accompany coal, in all the Irish coal districts, lie above the first floetz limestone; and no coal has ever been discovered, or is likely to be discovered interstratified with that rock.

PARTICULAR DESCRIPTION OF THE CONNAUGHT COAL DISTRICT.

It has already been mentioned, that the Connaught coal district occupies considerable portions of the counties of Roscommon, Sligo, and Leitrim, in the province of Connaught, and part of the county of Cavan in the province of Ulster. The external aspect of this district is mountainous and dreary; and its strata rise to a very considerable elevation above the secondary limestone country, on which they rest. The greatest length of the Connaught coal district in a north and south direction, from Doon Mountain to Keadue, is sixteen miles; and its greatest breadth from the hills above Swanlinbar to Killargy is sixteen miles. The area of the whole coal country within the edge of the limestone is about one hundred and fourteen thousand Irish acres,

exclusive of Slieve Russel, which is detached from the great district by the limestone valley of Swanlinbar. The precise boundary of the coal country may be seen by reference to the map. It ends where the blue colour, which represents the limestone, commences.

On viewing the coal country from the south, it exhibits a steep and straight ridge of high land, rising from one thousand to twelve hundred feet above its base, and extending fourteen miles in an east and west direction, but broken in the middle by the great valley of the river Shannon, which flows through it directly from Lough Allen. The external appearance of the coal country, when seen from the east, west, or north, is very similar to that of the south. The same steep and straight external ridge is visible on all sides. The summits of these ridges are universally flat, and are covered with shallow bog.

The aspect of the interior of the coal country is different from the exterior. The centre is occupied by Lough Allen, and the different tributary streams besides the Shannon, which flow into the lake, run in straight but deep vallies, *and divide the district into four parts.*

The river Shannon takes its rise from a circular gulph, about twenty feet in diameter, but of vast depth,* situated at the southern base of

* It is asserted by many persons much above the common rank in the country, that it was sounded with a line 200 yards in length, and that no bottom was found.

Culkagh mountain, in the interior of the district. The body of water issuing from this gulph probably flows from subterranean caverns contained in the limestone, which forms the nucleus of the mountain. The probability of this supposition will be apparent by reference to the geological section, which accompanies this Report. Though the limestone strata are not visible at the surface near the gulph, their depth beneath it was ascertained by a knowledge of the usual thickness of the beds of black slate clay† which cover it, the greater part of which are visible at the surface, immediately above the gulph, forming the steep acclivity of Culkagh mountain.

On leaving its source, the River Shannon at once assumes the deep, dead, and sluggish character, which it preserves for its whole extent. The elevation of the source of the Shannon, above Lough Allen, as ascertained by barometrical observations, is 115 feet, and above the sea is 275 feet.

The other tributary rivers are the Owenmore and the Arigna. The relative situation of these rivers will be seen by reference to the map.

The rocks, which form the coal series in the Connaught coal district, are similar to those usually met with in other coal districts. Be-

† The average thickness of the beds of black slate clay is 600 feet.

sides coal, they consist of alternations of sandstone, sandstone slate, slate clay, clay ironstone, and fine clay.†

The strata are arranged with great regularity, and dip or incline conformably with the limestone on which they rest, and contrary to the declivity of the hill. This is the case in the interior as well as the exterior sides of the hills; but the continuity of the different beds is frequently broken by the strata of one part of a hill having fallen or slipt down to a lower level from that of the other. These slips frequently occasion a difference of the level in the same bed, of twenty, forty, and even a hundred yards. A knowledge of the precise direction and amount of the fall of these slips is of the utmost importance to the coal miner; for if his workings, however excellent and perfect in their plan, be commenced and proceeded on in ignorance of these irregularities, when discovered in the progress of the work, they must lead to a greatly increased expence, or possibly to the abandonment of the colliery. With this view, great pains have been taken in prosecution of the survey, to ascertain the line of direction of the principal slips of the district. They will be found marked on the map in their proper situations.

† A particular description of the distinguishing character of these several rocks will be found in the Introduction to the Report on the Leinster coal district.

OF THE STRATIFICATION OF THE CONNAUGHT
COAL DISTRICT.

The general arrangement and alternations of the strata are extremely simple, and comparatively few in number ; but they are not exactly similar in all parts of the district, though some of them may be traced throughout.

OF THE SOUTHERN AND WESTERN DIVISIONS OF THE
CONNAUGHT COAL DISTRICT.

It has already been mentioned, that the deep vallies of the tributary streams, which flow into Lough Allen, divide the district into four parts. The stratification of the southern and western divisions, situated in the counties of Roscommon, Sligo, and Leitrim, are nearly similar, and may be classed together. These divisions are the most important in the district, both in respect to the extent and quality of the coal, and the facility of communication with the river Shannon and the neighbouring country.

The southern division is bounded on the north by the valley of the river Arigna, and on the south by the limestone country, which forms the southern boundary of the district. It consists of one great mountain ridge called Brahlieve. Its length from the Arigna works in the county of Roscommon to the hills above Ballintogher in the county of Sligo is nine miles ; and its average breadth from the edge of

the limestone country to the river Arigna rarely exceeds two miles. This ridge of mountains is straight, steep on both sides, and flat at the top. The strata, both on the northern and southern declivities, dip contrary to their inclination, at an angle of from five to six degrees from the horizon, and form a flat curve in the centre.

The western division consists of the Moun-terkenny mountains, which are bounded on the north by the Dorobally river, which falls into Lough Allen below Drumkeern; on the south by the river Arigna, which separates it from the southern division; on the east by Lough Allen; and on the west by the limestone country, which extends from Belhavel by Kille-nunnery to Ballintogher.

Though the strata are nearly similar in the southern and western divisions, it is not to be supposed that they are exactly the same in all parts; for a trifling difference will be found even in the short distance of twenty yards. Thus a bed, which is composed of soft slate clay, will gradually pass into sandstone slate, or thin beds of sandstone slate will be found inter-stratified with a bed of slate clay in one place, which do not occur in another. Beds of sandstone slate will also sometimes graduate into sandstone. But these are trifling variations, and of no importance to the miner: his guide should be the great and leading beds which occur in the country, whose general character and ap-

pearance are not materially affected by slight alterations either in the thickness or composition of some of its component parts.

The following table of the different rocks will shew the order, in which they occur in these divisions of the district, commencing with the limestone which lies below the coal series, and ascending regularly; ending with the bed of sandstone flag, which forms the uppermost stratum of the country.

TABLE OF STRATA.

No.		Thickness in feet.	
		Ft. In.	Ft. In.
1	Limestone, thickness unknown.		
2	Black slate clay. This bed rests upon the uppermost bed of limestone. Beds of sandstone slate, and even thin beds of sandstone are found interstratified with it towards the upper part. It contains numerous beds of clay ironstone, from half an inch to two feet in thickness. On an average its thickness is - - -	600	0
3	Greyish whitesandstone, known by the name of		

No.		Ft.	In.	Ft.	In.
	the first or great sandstone, from	-	30	to	60
4	Black slate clay	-	9	to	20
5	Grey sandstone	-	6	to	10
6	Sandstone with impressions, known by the name of seat rock	-	1	to	3
7	Fire clay, called coal seat	-	1	to	3
8	COAL, intermixed with thin laminæ of slate clay	-	1	to	3
9	Greyish white sandstone	-	4	to	20
10	Black slate clay	-	6	to	15
11	Sandstone	-	12	to	15
12	Good COAL	-	2	6 to	3 4
13	Grey soft slate clay, coal roof	-	10	to	15
14	White sandstone	-	24	to	45
15	COAL, upper bed	-	8	to	9
16	Slate clay, in beds of various thickness, and different degrees of hardness, but generally soft and black. These beds contain innumerable thin beds of clay ironstone	-	100	to	200
17	Blackish grey sandstone slate in thin layers	-	30	to	60
18	Sandstone flag	-	30	to	50

DETAILED DESCRIPTION OF THE DIFFERENT BEDS
OF ROCK, WHICH OCCUR IN THE SOUTHERN AND
WESTERN DIVISIONS OF THE CONNAUGHT COAL
DISTRICT.

No. 2. BLACK SLATE CLAY.—The thickness of this great bed, or rather accumulation of beds, varies from three to six hundred feet, but in the southern division it rarely exceeds five hundred feet. It rests immediately on the limestone. This bed is remarkable from the number and richness of the beds of clay ironstone it contains. The most important occur at the height of from two to three hundred feet above the limestone. Whilst the manufacture of iron continued at Arigna, some of these beds were worked, particularly those at Altagowlan, on the banks of the river Arigna. There are many other valuable beds of clay ironstone contained in this black slate clay, besides the above. The number visible in ascending the bed of the Arigna, is scarcely credible. In many places the whole breadth of the bed of the river is formed of one flag of ironstone, which is many perches in length.*

The thin beds in most cases are the best; though that at Altagowlan, which is one foot

* During the continuance of the iron works, the peasants collected the ironstone, when separated from the beds by recent floods, and made good wages by delivering it at the works, at the rate of two pence per hundred weight.

thick, is amongst the richest I have ever met with.

Beds of sandstone slate, and thin beds of sandstone, are sometimes found interstratified with the upper bed of this great mass of slate clay.

No. 3. GREYISH AND SOMETIMES YELLOWISH WHITE SANDSTONE. Next in importance to the coal and clay ironstone, we may place this accumulation of sandstone. It consists of a series of beds of various thickness and fineness of grain. The thin beds are much esteemed as flags; and the thick as building stone in different parts of the country. But for want of roads very few quarries are accessible for horses; and but one, with great danger, for cars.* On this account these most valuable quarries are comparatively of little use.

From its superior hardness this sandstone has remained unchanged, while the action of the weather has mouldered away, for a considerable depth, the softer beds of slate clay, which lie immediately above and below it, and left the sandstone projecting.

After much enquiry and minute examination of several precipitous ravines, in different parts of the district, in which the whole of the black slate clay beds were exposed to view, from the limestone up to the great sandstone, it was

* The only passable road is that to the quarry above Castle Tenison.

satisfactorily ascertained, that no bed of coal, or any substance of value, excepting the clay ironstone already mentioned, occurs in the district beneath the great sandstone; and consequently it becomes a guide of the utmost importance to the mineral surveyor, and serves as a point, or general station to be reached, previous to the commencement of any new mineral researches.

It sometimes happens, particularly in the north eastern division of the district, that this great sandstone forms the upper stratum of a tract of mountain; of course no particular investigation was requisite in such situations.

Though this sandstone varies considerably in thickness in different parts of the district, still it always retains the peculiar appearance of a projecting perpendicular crag or cliff, situated near the summit of the mountain, but elevated in some places one thousand feet more than at others. This is occasioned either by the increased thickness of the beds of black slate clay, No. 2; or by an unusual elevation of the limestone strata, which lie beneath the whole. Culkagh mountain, which will afterwards be described, affords a striking example of this fact.

No. 4. The great sandstone is succeeded by a bed of black slate clay, which contains nothing of importance.

No. 5. A BED OF SANDSTONE, which is rarely less than six feet thick, but frequently exceeds

ten feet; it is in general more compact and harder than the great sandstone, No. 3.

No. 6. SANDSTONE two feet thick, containing impressions of vegetable substances. This species of rock is universally known in the Irish collieries by the name of seat rock. This name is derived from its position with respect to a bed of coal. It is usually succeeded by fire clay, which is succeeded by a bed of coal. It sometimes happens that the fireclay is wanting, and then the coal rests on the seat rock.

No. 7. FIRE CLAY, called coal seat. In some parts of the district this bed is three feet thick; in others it is found two feet, and one foot; but in most places it is but a few inches, or is altogether wanting. These thicknesses are given from observations made in tracing the bed at its *outgoing*, or where it appeared at the surface. But it is probable that, were it of sufficient value to defray the expence of following it into the hill, the bed of fire clay would be found in most places to be three feet thick. In the valley of the Arigna, half a mile above the iron works, this bed was found to be three feet thick, and of excellent quality; and the whole of the fire bricks used at the works were made from it.

OF THE FIRST BED OF COAL.

No. 8. The fire clay is succeeded by a bed of coal, which varies in thickness from one to

three feet. It is known in the country by the name of the crow coal. It contains numerous thin laminæ of black slate clay, which render it of little value, except for burning lime. When first brought to the surface it is moderately solid; but on exposure to the air it soon divides into thin flakes.

This bed has never been wrought. If it were, I have little doubt its average thickness would be found to amount to three feet; but it has never been seen, excepting at the outgoing. In the vale of the Arigna, near the iron works, where the fire clay was wrought, this coal was three feet thick. This bed runs parallel to the three foot coal, which lies above it; and its outgoing may be traced along the face of the hills, through the greater part of the southern and western divisions of the district.

No. 9 and 10. The first of sandstone, and the other of slate clay, contain nothing worth mentioning.

No. 11. The lower part of this bed is composed of yellowish white compact sandstone: the upper contains numerous vegetable impressions. It is the seat rock of the second bed of coal. This sandstone bed is extremely hard, and usually projects from the face of the hill in the form of a great step, similar to that of the great sandstone bed No. 3 already described. This sandstone served as a guide to trace the line of the outgoing of the three foot coal, which lies immediately above it. In some

places a thin bed of fire clay is found interposed between this seat rock and the three foot coal.

OF THE THREE FOOT COAL, NO. 12.

The future prosperity of the Connaught coal district may be said to depend entirely upon the produce of this bed, which, though of moderate thickness, is fortunately of great extent. Its quality, as fuel for domestic purposes, is excellent; and if used for smelting iron, it is amongst the best in the empire. According to the analysis of Kirwan, 100 grains are composed of 71.42 carbon.

23.37 mixture of asphast and maltha.

5.21 grey ashes.

Specific gravity 1.351.

This bed of coal was first discovered in the western division of this district, on the property of Mr. Jones, two miles to the west of Lough Allen, and close to the boundary of the counties of Leitrim and Roscommon. This colliery was considered of such importance, that a parliamentary grant was voted to aid the formation of roads to it, but nothing in consequence was effected, and the colliery was soon after abandoned.

Unfortunately the first discovery of the coal was made very close to one of the greatest slips,

or faults * as they are commonly called, in the whole district, and the workings were commenced on the lower side. In the progress of working, whenever the colliers wrought upwards to the face of the slip, the coal was found to end; and no steps were apparently taken to ascertain whether or not it might be met with in other places.

The thickness of this coal is rarely less than three feet, or more than three feet four inches.

The line of its outgoing is dotted on the map. It follows the upper surface of the bed, No. 12.—Commencing at the iron works, it may be traced without difficulty along the northern face of the Brahlieve mountain, without any material interruption for four miles and a half, by Aughabehy colliery, nearly to Geeva point, in the county of Sligo, and from thence back again on the opposite side of the hill, to Tullylions' colliery; and afterwards round the eastern end of the mountain to the point above the Arigna works.

In the western division of the district the extent of coal is not so great as in the southern. Its boundary is also marked on the map, but not with equal accuracy, as the whole surface of the mountain is covered by bog; and the rocks, except at intervals, are completely concealed. This division may contain about 1200 acres of the three foot coal, which, added to 2800 acres

* See Appendix, No. 5. Note.

contained in the southern division, make a general total of about 5000 acres in both divisions.

From this calculation we should deduct one-fifth part to allow for impurities in the coal, and the loss occasioned by slips and undulations. This, at the rate of 7840 tons per acre, will leave upwards of thirty millions of tons of coal as the probable quantity which may be raised out of the southern and western divisions of the district. It is difficult to calculate, with even moderate precision, what quantity of the coal may hereafter be consumed in the country; but if we take it at 50,000 tons annually, which is much more than it will probably amount to, and allow 10,000 tons for the iron works, with one blast furnace, the total annual consumption would be 60,000 tons. But the southern and western divisions contain upwards of thirty millions of tons of coal, which is sufficient to supply the supposed demand for 500 years.

**OF THE DISLOCATIONS OCCASIONED BY SLIPS DOWN
OF THE STRATA, IN THE SOUTHERN AND WEST-
ERN DIVISIONS OF THE DISTRICT.**

Excepting in those situations where very great slips down of the strata have taken place, these disturbances are rarely visible at the sur-

face; they are usually discovered in the progress of working the coal.

The coal field of Aughabehy colliery is traversed by two great slips, which converge towards each other, as represented on the map. The eastern slip has thrown down the coal to the west, and the western to the east; between them the coal lies at a much greater depth from the surface than on their exterior sides. The coal field situated to the north of the river Arigna is also traversed by two principal slips, which run nearly at right angles to each other. They have divided the coal into three distinct parts. These coal fields are probably traversed by many other slips, which are not visible at the surface, but certainly by none of equal importance with the above.

OF THE DIFFERENT PLACES WHERE COAL HAS BEEN
WORKED, IN THE SOUTHERN AND WESTERN DI-
VISIONS OF THE CONNAUGHT COAL DISTRICT.

It has already been mentioned, that the three foot bed of coal was first discovered on Mr. Jones's property, in the county of Leitrim. In this place a few acres of coal were wrought out, between the great eastern downthrow of the western division of the district, and the outgoing of the coal. (See map.) This colliery was known by the name of the Mounterkenny

colliery. Adjoining to it on the opposite side of the stream, which forms the boundary of the counties of Leitrim and Roscommon, a few pits were sunk in the lands of Celtenaruny, belonging to Colonel Tenison, and Tullynah, belonging to Mr. Lloyd; but very little coal was ever raised.

If we except two or three trial pits, which were made two miles to the south-west of the Mounterkenny colliery, it is the only place where coal has been wrought in the western division of the district.

The great extent of coal situated near the summit of the Table mountain of Mounterkenny, as represented on the map, remains unknown to the proprietors of the land, and the inhabitants of the country.

On an average, the Mounterkenny coal field is elevated seven or eight hundred feet above the level of Lough Allen. The surface of the mountain is covered with bog throughout, and no rock is visible, excepting on the declivity of the mountain. From this circumstance it is impossible, merely from external observation, to say at what depth below the surface the coal may occur in the interior of the field. A few trials, either by boring or sinking, in well selected situations, would satisfactorily determine this point. These trials are absolutely necessary as a preliminary to any extensive workings in this part of the district.

The extent and value of the great coal field

in the southern division of the district is better known than that of any other in the country. In this division coal has been discovered and worked in many places near the outgoing of the coal, but particularly at Aughabehy and Tullylions on the property of Colonel Tension; at the Rover colliery, near the iron works, on lands belonging to the Archbishop of Tuam; and at Greaghnergara, the property of Mr. M'Dermot. These collieries are all situated in the county of Roscommon.

OF AUGHABEHY COLLIERY.

During the continuance of the Arigna iron-works considerable workings were made at this place to supply them with fuel. The colliery is situated two miles to the west of the iron-works, and to the south of the great northern slip. The extent of the coal already wrought out does not exceed six or seven acres. Though this colliery was situated close to the declivity of the hill, the whole of the coal was drawn up to the surface through shafts; but the water was carried off by a level.

Aughabehy colliery was worked by the company, who carried on the iron works. It would appear from some of these works, which still remain, that this company meant at one time to work this colliery on a very extensive scale. They commenced driving a deep level from the

northern declivity of the hill, and considerably below the outgoing of the coal, with an intention, it is said, of carrying it entirely through the mountain, and by this means unwatering the whole coal field which extends from the north to the south side of it; but this magnificent project was abandoned before the level or water drift had been driven a sufficient length to be of any use.

This drift was commenced on too low a level, and the apparent cause of its abandonment was the ruinous expense of sinking air shafts to ventilate it. Had it been commenced fifty yards below the level of the outgoing of the coal, instead of the great depth at which it was attempted, no more than one air shaft would have been requisite till after it had been driven a considerable distance under the coal, and the second air shaft might have been commenced and sunk from the coal downwards to the drift.

At Aughabehy the coal inclines towards the south at an angle of 7° from the horizon, which is equal to a slope of one foot in ten, and consequently, for every ten yards the water drift had to proceed beyond the outgoing of the coal, the depth of the air shaft would diminish one yard. These air shafts, sunk underground from the floor of the coal to the water drift,*

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* The whole of the Duke of Bridgewater's collieries near Manchester are worked according to this plan.

would have the effect of ventilating both the water drift and the colliery ; for, after the air shaft was perfected, a current of air might easily be carried, commencing at the mouth of the water drift, ascending the air shaft to the colliery, and afterwards passing through the different workings of the mine ascend any old coal pit that might be selected.

A large fire should be made at the bottom of the coal pit, to rarify the air, and by this means force the current in the direction desired.

If this water drift were carried on five hundred yards, it would reach the coal. But, long before it arrived there, it might render the most essential benefit to the mine, not only in conveying off the water, but by being used as a canal the whole of the coal might be cheaply and expeditiously drawn out in small boats. To reach the boat level it would be requisite to let down the coal through the air shafts, and the descending full buckets or baskets might draw up the empty ones. This plan would be much less expensive than drawing the coals through deep pits up to the surface.

By reference to the section of the rocks, as given in the table, it will appear that, fifty yards below the level of the coal, the strata are composed of soft slate clay ; consequently the first two hundred yards of the boat level would pass through this rock, the next eighty yards through the great sandstone, which is composed of alternating beds of sandstone and sandstone flag,

which may be easily wrought. The remaining one hundred and twenty yards would pass through the crow coal, and alternations of sandstone and slate clay.

The cutting through eighty yards of the great sandstone would be the only expensive part of the proposed boat level.

OF THE METHOD OF WORKING THE COAL AT AUGHABEHY COLLIERY.

The three foot coal at Aughabehy, and in most other places where it has been worked, is divided into three parts. Commencing from the bottom the sandstone seat rock is covered by one foot four inches of solid coal; this is succeeded by two inches of slaty coal called kelves, and over this again is one foot six inches of solid coal of excellent quality. The roof is composed of soft dark grey slate clay. The coal is easily separated from the roof; it rarely adheres strongly to it.

The plan, which was followed in working the colliery, was simple and well adapted to the nature and arrangement of the bed of coal. It was what is called the Broadway. When the pit was sunk to the coal, double drifts * were carried on both sides of it forty yards in length

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* The method of driving double drifts, and supplying them with a constant current of fresh air, is described in page 81 of my Report on the Leinster Coal District.

on the level of the bed, that is at right angles to its dip. These drifts being parallel, of course one was more to the dip of the stratum, or on a lower level than the other. The workings were commenced from the upper side of the upper drift, or, as miners term it, the upper side of the rise drift.

Ten colliers, called clearers, were sent into the drift, who placed themselves four yards asunder, and commenced working by cutting out or clearing away the bottom of the coal, close to the floor. When these ten men had finished their work, they had made an incision in the bottom of the coal, three feet in from the face of the drift, and six inches high, for the whole length of the working, or forty yards.

The clearers were followed by two breakers and fillers, who broke down the coal by wedges driven in at the top, and afterwards fitted it into wooden boxes having slides fixed to the bottom. Each box held two hundred weight. Four hurriers were next employed to draw the coal from the working to the pit bottom, from whence it was drawn up the pit to the surface. This being completed, a pillar-man was sent down, who built small pillars to support the roof, with sandstone, which had previously been let down the pit for that purpose. These pillars were placed in the centre of the drift, at the distance of three feet from each other.

The next day the whole operation was repeated, and a second row of stone pillars were built, one yard to the rise of the first, and three feet asunder.

As the work proceeded, a passage, called a hurrying road, was formed diagonally from the pit, so as to reach the farthest angle of a rectangular working, which varied according to circumstances from sixty to eighty yards in length, but rarely exceeded forty yards in breadth. To preserve this hurrying road, walls were built on both sides, formed of the roof of slate, which was taken down to encrease the height of the passage.

To preserve a constant current of fresh air at the workings, air courses were formed between walls built of the slate of the roof on both sides of the breadth of the general working, and communicating with the lower drift first made.

When the workings were carried on to a length of seventy or eighty yards from the pit, double doors* were placed in the hurrying roads, to force the air round the circuit of the air courses.†

* The advantage of using double doors in the workings of a colliery is explained in page 83 of my Report on the Leinster coal district.

† A plan and description of the broad method of working coal, very similar to that here described, is given in my Report on the Leinster coal district. The principal difference consists in stone permanent pillars being substituted for move-

The principal objection to this plan of working is, that the air courses are composed of porous walls built of slate clay, instead of being cut, as is usual, out of the solid coal, and protected on either side by pillars of coal. But at Aughabehy colliery, as formerly worked, the pits were so shallow and numerous, that little precaution was requisite to supply the moderate extent of the workings of each with fresh air.

Had the colliery been more extended, and the workings been carried further to the dip, a more perfect system of ventilation would have been indispensable; for, in proportion to the increased depth of the coal from the surface, fewer pits would have been sunk, and a greater extent of workings must necessarily have been ventilated from each.

The number of pits formerly worked at Aughabehy colliery caused a great encrease per ton in the expense; as each pit required a certain establishment, and consequent expense, whether little or much coal was raised out of it.

From the best calculation I have been able to make, a ton of coal of twenty hundred weight cost the Arigna company, when delivered on the pit bank, about four shillings, exclusive wooden ones; and the hurrying road being made diagonally across the coal working, instead of through the permanent air courses.

sive of the royalty to Colonel Tenison of one shilling per ton. Had horses been used underground to draw the coal to the pit bottom, and the works in each pit more extended, it might have been raised for three shillings per ton, and even less, if the boat level system were brought to perfection.

In the last working of this colliery a contract was made with the Arigna company by Mr. John Colthard,* to supply them with coal at the rate of five shillings per ton at the pit mouth. There is at present but one pit at work at Aughabehy. It is situated to the south of the old colliery; and Colonel Tenison, the proprietor, pays five shillings a ton to the colliers for delivering it to him on the surface. The quantity of coal at present raised per week, on an average, is about twenty tons.

TULLY LIONS' COLLIERY.

This colliery, which belongs to Colonel Tenison, is situated to the south of Aughabehy, and on the opposite side of Brahlieve mountain. It has been partially worked at different times, and many pits have been sunk to the coal. Colonel Tenison is at present driving a short level, which will unwater a small extent of the coal,

* Mr. Colthard is still resident in the country, and I am much indebted to him for the information and the kind assistance he afforded me in the progress of my mineral survey.

situated between the declivity of the mountain and the great western downthrow.

When this level is completed, he intends to abandon the Aughabehy colliery and work at this place. His inducement to make this change is not from any variation in the quality of the coal, but to take advantage of the new road now making to Tully Lions.

Some pits have been sunk, and a small quantity of coal has been raised at a place called Greaghmagara, half a mile to the north-west of Tully Lions' colliery; and also near to the iron-works, at a place called the Rover. The coal raised at the latter colliery was inferior in thickness and quality to that of Aughabehy and Tully Lions.

This difference probably arises from the workings having been made close to the outgoing of the coal. When followed to the dip, there is little doubt of its being found equal to any in the country.

The Rover colliery is worked occasionally in the spring and summer. It may produce on an average 300 tons in the year. Aughabehy colliery produces about 1000. It therefore appears that 1300 tons per annum are the entire produce of the collieries of the southern and western divisions of the Connaught coal district, which contain, as already stated, upwards of 30,000,000 of tons of coal; the whole of which is at a moderate depth beneath the surface, and may be easily wrought.

But there are no passable roads to the coal hills, and until they are formed nothing can be effected. The lines of new road, which are apparently the most important, as leading to the principal markets, will be described towards the conclusion of this Report.

SECTION OF THE STRATA, CONTINUED.

No. 14. The three foot coal is covered by a bed of grey slate clay, which varies from ten to fifteen feet in thickness.

No. 15. It is succeeded by a bed of hard white sandstone, which forms the floor of the upper bed of coal. This sandstone varies very much in thickness. At Tully Lions' colliery it is twenty-four feet. At Aughabehy, to the north of the great slip, it is forty-five feet. At the Rover colliery a bed of slate clay, of fifteen feet in thickness, separates this sandstone into two distinct beds.

No. 16. Coal, which varies from eight to nine inches in thickness. It is the uppermost bed of coal in the district, and has not been met with, excepting in the southern division.

No. 17. The eight inch bed of coal is covered by an accumulation of beds, usually of black slate clay, containing numerous thin beds of clay ironstone, and sometimes beds of sandstone slate. This mass of slate clay is usually much decomposed at the surface; and some-

times it forms mural precipices near the summits of the hills. It varies from one hundred to two hundred feet in thickness.

No. 18. Blackish grey sandstone slate. This bed is easily separable into thin layers or flakes, and, though subject to decomposition, it is much used for roofing houses in the vicinity of coal districts. It is, however, much harder, and more durable in some quarries than in others. Its thickness varies from thirty to forty feet.

No. 19. Sandstone flag. This is the uppermost bed in the Connaught coal district. It is only to be met with in the summit of the Brahlieve ridge of mountain near its south-eastern extremity. This bed is also used for roofing houses, and is much superior to the foregoing for that purpose. It varies from thirty to sixty feet in thickness.

I have thus described the nature and thickness of the several beds of coal and other rocks, which occur in the southern and western divisions of the Connaught coal district, from the limestone upwards. It appears that these divisions contain but three beds of coal, only one of which is worth working. Yet this single bed, though but three feet in thickness, is, from its great superficial extent, sufficient to supply the country with fuel for many centuries.

OF THE NORTHERN DIVISION OF THE CONNAUGHT
COAL DISTRICT.

This division contains the mountains of Lacka, Lagnacuilla, Culkagh, Doon, and Glanfarn or Mullaghurk, and several others of minor importance. It is bounded on the north, east, and west, by the limestone country, which forms the boundary of the coal district, and which on the map is coloured blue; and on the south by the valley of the Drumkeeran river, which separates it from the western division of the district, and by the deep valley of the river Owenmore, which separates it from the Slieve or Nirin mountains.

The surface of this division is much more diversified than those already described. The five mountains, already mentioned, do not form a single chain or group, but are separated from each other by deep and broad vallies, which also contain innumerable low but steep hills. The mountains are all of similar character. They rise at a steep angle from their bases, and frequently present mural precipices, from sixty to one hundred feet in height. On the summits they are all nearly flat, and covered with bog.

The general arrangement of the stratification is very similar to that of the southern and western divisions, though some diversity is apparent in the upper beds where the coal is found.

There is also some difference in the lower stratum, which, particularly in the valley between Lough Macnean and Lough Allen, is composed of sandstone.

In several parts of this valley limestone rises up from beneath this sandstone, and is quarried by the inhabitants, who burn it for manure. These risings up of the limestone are evidently occasioned by undulations in the stratification; for the beds are universally found to incline from the body of the limestone towards the adjoining sandstone hill, which covers it. These insulated tracts of limestone generally occur near the boundary of the coal district, but there are instances of their occurrence considerably in the interior: there is one three miles east of Dorobally, close to the river Shannon, upwards of three miles to the south of the nearest limestone boundary.

The situation of these small, but useful patches of limestone is shewn on the map by the blue spots within the boundary of the coal district.

The bed of sandstone, which covers the limestone, is very variable in its thickness. In some places it exceeds forty feet; in others it is less than ten feet. It is generally extremely compact, and difficult to break. Its texture varies from fine to very coarse grained. It is succeeded by a great bed, or accumulation of beds of black slate clay, from two to five hundred feet in thickness, similar to that already described

as occurring in the southern and western divisions of the district.

Thin beds of a black and impure argillaceous limestone, very similar to calp, are found interstratified with the lower beds of the slate clay. Extensive quarries of this limestone or calp have been opened at the base of Glanfarn or Mullaghurk mountain near the road, which leads from Manorhamilton to Enniskillen; particularly at Cornacloy, three miles and a half from Manorhamilton. Several quarries have also been opened near Drumkeern and Dowbally.

The black slate clay is succeeded by a great bed of sandstone, which varies in thickness from forty to sixty feet. Some parts of this bed are extremely fine-grained, and of a yellowish white colour. Extensive quarries are worked in it near the summit of Glanfarn mountain, and the stones are drawn all over the country, and used for window-stools, flags, and sometimes for pillars and ornamental stone work. But the quantity raised is limited by the difficulty of conveying the stone from the quarries to the base of the mountain. At present there is no road, and all is drawn down the hill on rude slide cars. No pains are taken to open the quarries, and most of them at present are nearly filled up with rubbish.

Besides Glanfarn, this great bed of sandstone occurs near the summits of the mountains Cul-kagh, Lacka, Lugnacuilla and Corkagh; and

quarries similar to those of Glanfarn, when found convenient, may be opened in them.

On Glanfarn and Culkagh the great sandstone forms the uppermost bed. We may, therefore, conclude that those mountains contain no coal.

Culkagh mountain is by much the highest in the country. From two sets of barometrical observations, the height of the mound, at the western extremity of the summit, was found to be 1995 feet above Lough Allen, or 2155 feet above the sea. This great elevation is not occasioned by an increased thickness of the strata belonging to the coal formation, but to their resting on hills composed of limestone, which, to the west of the valley of Swanlinbar, rise to a height of fifteen hundred feet above the level of the sea.

It is remarkable that the surface of these calcareous hills is nearly strewed over with large rolled masses of sandstone, which at first deceive the observer, and lead him to suppose the mountain is composed of sandstone. But on examining the beds of any of the precipitous streams, which traverse the steep declivity, he quickly discovers that the whole of the lower mountains are composed of limestone, sometimes interstratified with thin beds of grey slate clay.

This great accumulation of rolled sandstone must, at some period, have formed a part of the great sandstone bed, which, on the summit of

Culkagh mountain, is rarely less than sixty or seventy feet thick. The black slate clay, which lies below the sandstone, is extremely soft and decomposed. In consequence, after every frost, huge masses of the sandstone, losing the support of the slate clay, are precipitated from the summit of the mountain into the valley beneath some of these masses, which are still visible, exceeding five hundred tons in weight.

The summit of Culkagh mountain resembles an immense pavement of sandstone, traversed in every direction by great cracks and open fissures. Frequently, at the distance of from eighty to a hundred yards from the edge of the precipice, frightful gulphs are met with, from twelve to twenty feet wide, and open from the surface of the mountain to the bottom of the sandstone, a depth of about seventy feet. Similar appearances, though on a smaller scale, are visible on the summit of Glanfarn mountain.

As far as I have been able to observe, the summits of Lacka and Lugnacuilla mountains are the only situations in the northern division of the district, where coal is likely to be met with.

The stratification of these mountains is similar as far as the great bed of sandstone, but above it great differences are observable. It will, therefore, be necessary to describe each separately.

OF LACKA MOUNTAIN.

The base of Lacka mountain, on its west side, in the vale of Glanboy, is composed of limestone, which dips towards the mountain at an angle of 60° . It is covered by the great bed of slate clay. In this place the first bed of sandstone, already mentioned as occurring in the northern division of the district, is wanting. The slate clay is 615 feet thick. It dips in a direction contrary to the declivity of the mountain, at an angle of 6° . from the horizon. It is covered by the great sandstone, which in this place varies from sixty to eighty feet in thickness.

On the north side of the mountain the stratification has been much disturbed by three or four great slips; and the falling down of the sandstone stratum at each has formed a succession of abrupt precipices, with considerable flat intervals between, giving the appearance of gigantic steps. The perpendicular face of each cliff is formed of sandstone.

At first sight, the north face of the mountain appears to contain five successive beds of sandstone, each sixty feet thick. There is, however, but one bed of that thickness, which, by successive slips, has assumed the appearance first described; and this is fully proved by the occurrence of but one thick bed of sandstone in the vale of Glanboy, on the west side of

the mountain ; which bed, in continuation, forms the uppermost of the five apparent beds, visible on the north side.

These facts are the more dwelt upon, as the knowledge of them may prevent future mistakes, and possibly fruitless trials for coal.

The great sandstone on Lacka mountain is succeeded by a bed of slate clay, about thirty feet thick ; and this by a second bed of sandstone, of about twenty feet. Above it is a series of layers of coal, which alternate with thin beds of sandstone ; the layers of coal vary from four to six inches in thickness ; the sandstone beds are each two feet thick. They contain irregular masses of coal. These alternating beds are covered by a stratum of sandstone slate, one feet six inches thick ; it is succeeded by a bed of sandstone ten feet thick.*

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* An imperfect trial for coal has been made by some peasants on the summit of Lacka mountain. The openings were made like quarries. The strata sunk through were,

	Ft.	In.
Sandstone flag	10	0
Alternating thin layers of soft micaceous sandstone slate, and coal	1	6
Slaty coal, called kelve	0	3
Sandstone, containing coal and vegetable impres- sions	1	10
Coal	0	5
Sandstone, containing coal and vegetable impres- sions	1	8
Coal	0	6
Sandstone not penetrated.		

This bed was traced round the summit of the mountain, forming an irregular ellipse, whose area may contain about two hundred and fifty acres.

The appearance of this coal, and the layers of rock which accompany it, are not very similar to any of those contained in the southern and western divisions of the district. In point of situation, it occupies the place of the first bed of coal, known by the name of the crow coal, but in other respects it bears no resemblance to it.

Nearer to the centre of the summit of the mountain, the sandstone, which covers the coal, is succeeded by two distinct beds of sandstone of considerable thickness. The intermediate space is so covered by bog, that the beds of slate clay, or other substances which are probably interstratified with them, are not visible at the surface.

The last bed of sandstone forms the uppermost stratum of the mountain. It is extremely irregular in its appearance. In some places it is much shivered and broken. If the coal already discovered at Lacka mountain be the first, or crow coal of the southern and western divisions of the district, we may expect to find the three foot coal beneath the uppermost sandstone, and resting upon the second; but unfortunately its occurrence there is very doubtful.

The coal of Lacka mountain is but three miles distant from Manorhamilton, and ten from Sligo. At present there is no road to it, and, owing to the great elevation* of the coal above Manorhamilton, much skill will be required to select the most eligible line.

LUGNACUILLA.

If we except the interposition of a bed of sandstone at the base of this mountain, between the limestone and the black slate clay, its stratification is similar to that of Lacka, at least as far as the great sandstone.

This rock, which is full sixty feet thick, forms a mural precipice near the summit of the mountain. It is succeeded by a bed of black and grey slate clay, which varies from twenty to thirty feet in thickness. Above it is a bed of sandstone three feet thick. This bed forms the floor or seat of a bed of impure slaty coal, ten feet thick. Towards the centre of the stratum there is a layer of good coal, which varies from six to ten inches in thickness. Above the coal is a bed of soft black slate clay, twenty feet thick. It is succeeded by a bed of hard coarse-grained sandstone, fourteen feet thick: this

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* According to barometrical measurement, the coal in Lacka mountain is 1150 feet above Manorhamilton.

bed reaches the boggy surface of the mountain. Towards the summit there are two additional beds of sandstone ; but the strata, which lie between them, are so concealed by a deep covering of bog, that it is impossible to ascertain their composition without sinking or boring through them.

The ten feet bed of coal is visible on the eastern face of the mountain at a place called Meneask, in the county of Cavan, where some trifling workings have been made. A pit was also sunk in the top of the mountain, a short distance from the face of the cliff. The coal found was similar to that visible in the precipice. Three other pits were sunk in search of coal in this mountain, but all of them were commenced beyond the outgoing of the coal, and sunk through strata which lie below it. Two were commenced in the slate clay, which rests upon the great sandstone, and one in the great mass of slate clay, which lies below that rock.

The situations of these pits must have been selected by persons unacquainted with the general stratification of the country.*

The extent of the impure bed of coal in the summit of Lugnaculla mountain may be about 600 acres. Part of it lies in the county of Ca-

* I understand they were made by order of Mr. Pleydel, the proprietor of the land, by some English colliers who were brought over for the purpose.

van, and part in the county of Leitrim. The boundary of these counties crosses over the summit of the mountain.

It is possible that the bed of sandstone, already mentioned, which lies twenty feet above the ten feet coal, may be the floor or seat of an upper stratum, though none of the vegetable impressions, and other characteristic marks which usually distinguish a seat rock, were visible in it. But the uppermost layer may not have been seen, which is frequently the only one that contains those impressions.

According to barometrical measurement, the coal pit at Meneask is 1010 feet above Lough Allen, and 1170 feet above the level of the sea. There is at present no road to it.

OF THE EASTERN DIVISION OF THE CONNAUGHT COAL DISTRICT.

This division is bounded on the north by the valley of the river Owenmore, which separates it from the northern division; on the west by Lough Allen; and on the east and south by the limestone country which bounds the coal district.

It is composed of one mountain group, known by the name of Slieve a nirin.* The ex-

* The Iron Mountain.

ternal appearance of these mountains is similar to those contained in the southern, western, and northern division of the district; but in some respects the stratification is different.

In many places the limestone, which forms the substratum of the coal district, is succeeded by an alternation of thin beds of sandstone, slate clay, and sometimes grey impure limestone; these strata, in the aggregate, amount to upwards of one hundred feet in thickness. They occur in the line of country between Drumshambo and Aughacashiel.

To the north-east of Aughacashiel these strata are succeeded by a bed of white sandstone, which varies from ten to forty feet in thickness. This sandstone is covered by the great bed of black slate clay, which occurs in every part of the district. It varies in thickness from three to five hundred feet. The slate clay is succeeded by a bed of sandstone forty feet thick.

In some places thin beds of slate clay are found interposed between the sandstone beds at Aughacashiel. The section of the strata, from the great sandstone upwards to the summit of the mountain, is as follows:

				<i>Feet. In.</i>	
The sandstone is covered by grey					
sandstone slate		-	-	60	0
Sandstone		-	-	5	0
Coal		-	-	1	6

	<i>Feet.</i>	<i>In.</i>
Fireclay, extremely slaty and im- pure, from 8 feet to	10	0
Sandstone	2	0
Coal, irregular and slaty	1	6
Sandstone, extremely irregular, and varying in thickness from 6 to	30	0
Sandstone containing vegetable im- pressions	3	0
Coal, slaty and impure, varying in thickness from 6 inches to	1	0
Black slate clay	15	0
Greyish white sandstone	30	0
Black slate clay, visible in the face of the precipice,	50	0

This stratum reaches the flat surface of the mountain, but, as the strata incline towards its centre, it may be of great thickness. Nothing further can, however, be discovered without sinking through the deep bog, which extends over the whole table surface of the top of the mountain.

It would appear from the foregoing section, that the eastern division of the district contains three beds of coal. Their superficial extent is very great; but they are extremely irregular, and the strata, which accompany them, were never found to be the same for a quarter of a mile in any direction.

Finding this to be case, less trouble was taken to ascertain the actual extent of the coal

than would have been requisite, had the beds been more regular or of greater thickness.

Some tifling workings have been made on the different beds of coal at Aughacashiel; but the most extensive were on the lowest bed. These workings are at present nearly closed up; they were commenced by drifting horizontally from the face of the precipice. The coal, as might be expected, was found to be thicker and more solid in the interior than at the surface. If it should encrease to two feet in thickness, a very beneficial colliery might be carried on for the supply of the county of Cavan and part of Leitrim. A road of easy ascent has been made to Aughacashiel colliery; and, if it were kept in repair, carts or drays, each holding a ton of coal, might be loaded there, and drawn with great facility down the hill. If, as already observed, the coal be found to encrease to two feet in thickness, it might be sold at eight shillings a ton, and at this rate an ample market would be found in the neighbouring country, extending to the town of Cavan.

The stratification of the four divisions of the Connaught coal district have thus been described. Each of them contains workable beds of bituminous coal; but that found in the southern and western divisions is greatly superior in quality, and more widely extended than the coal of the northern and eastern divisions.

OF THE IRON WORKS.

The number and richness of the beds of clay ironstone, that occur in all parts of the Connaught coal district, appear at a very early period to have attracted the attention of Irish speculators; and works on a very small scale, called Bloomeries, were carried on in various parts of the adjoining country, as long as any wood remained to supply them with charcoal. At that time no coal had been discovered, and if it had, the process of making iron from pit coal was then, though partially known, not practised even in England.

The iron works of Drumshambo were the last that continued to work: they were given up about the year 1765. These works were situated at the southern extremity of Lough Allen, in the county of Leitrim, a quarter of a mile west of the village of Drumshambo.

The works were built upon a limestone rock, but about a quarter of a mile from the commencement of the coal country. The situation was particularly favourable for making iron at a cheap rate. The ironstone was chiefly collected from the eastern shore of Lough Allen, and in the beds of the precipitous streams which

descend from the Slieve a nirin mountains to the lake.

The appearance of trivial workings, made in search of the ironstone, are still visible along the borders of these streams. The ironstone, when collected, was conveyed by boats to the works; and charcoal from the vast woods, which at one time flourished in all the vallies, was carried by the same means. Limestone, the only remaining ingredient for smelting iron, was quarried close to the works.

Judging from the accounts given by the oldest inhabitants, and the remains still visible, the Drumshambo iron works appear to have consisted of one blast furnace, three feet square* in the interior, and about eighteen or twenty feet high.

Large heaps of ironstone, of excellent quality, still remain at the works. It is much superior to the greater part of that used at the more modern Arigna iron works. The smelted iron from the Drumshambo works was carried to the neighbouring village, where it was forged into bars.

OF THE ARIGNA IRON WORKS.

These works were commenced in the year 1788, by three brothers of the name of

* The whole of the ancient iron works, that I have seen in Ireland, were of similar construction.

O'Reilly. At that time the practicability of smelting iron with charred pit coal, or coak, instead of wood charcoal, was well known, and long practised in England and Scotland with great advantage to the adventurers.*

The Arigna works, being the only ones ever erected in Ireland to smelt iron with pit coal, attracted great attention, and their want of success has in consequence been deeply felt. It is of some importance, that the true cause of their failure should be investigated, that men of capital and enterprize may not be deterred by groundless fears from embarking in a speculation, which, if conducted with judgment and prudence, would enrich themselves, and be of infinite advantage to the country.

From a very minute examination made on the spot, the quality of all the requisite materials were found excellent in their kind; and although the cost of each, when delivered at the works, was greater than it might have been

* A patent was granted to Dudley for making iron with pit coal in the year 1619; but his works were destroyed by the populace, instigated, it is supposed, by the iron masters who made iron from charcoal. No further attempts appear to have been made for upwards of a century. Between the years 1750 and 1760, many blast furnaces were erected in England and Wales to smelt iron with pit coal, and the number continued afterwards to increase rapidly. In the year 1788, the year in which the Arigna works were commenced, there were fifty-three blast furnaces in England and Wales, and six in Scotland, whose annual produce in cast iron amounted to 53,800 tons.

by superior arrangement, or the application of mechanical contrivance, still cast iron of the very best quality could have been manufactured at Arigna for three pounds four shillings per ton; while cast iron, called pig iron, greatly inferior in quality, sells in Dublin at the rate of ten pounds per ton.

The data, on which this statement is made, will be given in detail as we proceed; and the conclusions drawn from my own observations are strengthened and confirmed by the opinions of two excellent and impartial judges, Mr. John Greeve of Edinburgh, who examined the works in the year 1800, and Mr. Thomas Guest, of Dowlais iron works in Glamorganshire, who viewed them in the year 1805.* It would therefore appear, that a profit of £6 16s. per ton could have been made on cast iron, exclusive of carriage.

Many persons have imagined, that the expense of land carriage to Dublin, a distance of eighty-four miles, was the cause of the failure; but even at the rate of one shilling a ton per mile, the expense would be but £4 4s. and therefore there would still remain a profit of £2 12s. per ton on pig iron. But land carriage was not the best means of transporting iron from the works to Dublin. The cheaper mode would have been to ship it at Sligo, which is

* These valuable Reports are given in the Appendix, Numbers 1 and 2.

only eighteen miles distant from Arigna. By this channel the carriage of pig iron to Dublin would cost the proprietor but £.2 10s. per ton, that is, £1. for land carriage to Sligo, and £1 10s. freight and insurance to Dublin.

By these means, if the proprietor sold his iron for £10 per ton, he would have a clear profit of £3 10s. per ton.

We must not, therefore, attribute the failure of the Arigna works solely to the expense of carriage to Dublin. In fact it was not the case; for the whole was sold on the spot, either forged into bar iron, or cast into small articles for domestic uses.

I am of opinion that the works were originally commenced on too extensive a scale; and so much money was expended in the infancy of the undertaking, to make malleable as well as cast iron, that little was left towards keeping the works in repair, or improving the means of conveying the materials to the works.

But perhaps the frequent change of managers tended more than any other cause to accelerate the failure of the undertaking; the plans of each new master being generally at variance with those of his predecessor caused great additional expense, by the destruction of old and the erection of new works. Many indeed were undertaken, which sound judgment would have disapproved, and some most useful

ones were injudiciously destroyed. Amongst the latter was the removal of the iron rail-way from the inclined plane to the north of the furnace pool. It was a very useful work, though not perfect, as there was a rise from the bottom of it to the works, which might easily be avoided; the construction of the great dam across the Arigna, above the works, was inconsiderately undertaken, as the destruction of the bank on either side was a catastrophe, which might naturally have been expected from the constant pressure of an immense body of water, aided, in time of flood, by the furious rapidity of a precipitous mountain torrent.

It would be useless to enter into any more minute detail respecting the cause of the failure of these works; but I have great confidence in asserting, that there is no situation in the empire, in which cast iron can be manufactured at a cheaper rate, or of superior quality, than at Arigna.

The Arigna works are situated at the southern base of Brahlieve mountain, on the west side of the river Arigna, and about one mile distant from Lough Allen. The works, as first constructed, were divided into two distinct parts, the upper and lower works. The iron was smelted, and all castings were made in the upper works; and the lower were confined to rendering cast iron malleable, and forming it into bars, &c.

The upper works ; at present consist of,

A large furnace pool ;

A blast-furnace, forty-four feet high, and twelve feet in the bosh ;

One large overshot water-wheel, twenty-six feet in diameter :

It worked two cast iron cylinder bellows, which blew the furnace, and also a large boring mill attached to the water-wheel shaft :

One double steam engine of Bolton and Watt's construction, the cylinder thirty-two inches in diameter, with a blowing cylinder five feet four inches diameter. This engine was used to blow the furnace in dry seasons, when there was not a sufficiency of water to work the water-wheel.

One foundery, with a cupola furnace.

One horse-mill for grinding fireclay.

Three draw-kilns for roasting the ironstone, with store-houses, offices, and other buildings.

The furnace-pool is large, and has been formed at a considerable expense ; but the supply of water was uncertain, particularly in the summer season, which was of great detriment to the works.

To remedy this defect the steam engine was erected. It would have been better to have taken in part of the river Arigna, by forming a weir about a mile above the iron-works, and carrying a mill-race nearly on a level from thence to the works. The mill-race would cer-

tainly have been expensive, as there are many small mountain streams, over which it must have been carried by aqueducts ; but the expense would soon have been repaid by the blast furnace being constantly kept at work, and by the power it would have given of working any machinery on the level of the lower works by the water from the tail-race of the furnace wheel of the upper.

The blast furnace is extremely well erected, and firmly bound together. The interior is lined with fire-brick, and is in good repair. Previous to the stopping of the work, the whole of the bottom was removed, apparently to make some improvements.

The large water-wheel is extremely strong, and well constructed : the arms are made of oak, and are well framed together. With some slight repairs to the buckets, the wheel might be set to work without delay. The blowing apparatus would require some repair, and a water pressure should be added to render the blast regular.

The double steam engine has been ill constructed from the beginning. The top of the blowing cylinder has been taken off, and the interior, from being exposed to the weather, is now quite eaten with rust. The air-pump is in a similar condition, and the steam cylinder and working gear are so much out of repair, that little benefit can ever be derived from the engine, without expending more money on it than

it is worth. There is a new steam boiler in the yard, which has never yet been set ; it is much corroded by long exposure to the open air. The cupola furnace is apparently in good order, as are also the draw kilns for roasting the iron-stone.

The roof of the store-houses and other buildings have lately been repaired ; they contain a great variety of excellent patterns for casting.

Little need be said about the lower works ; they are at present in such a ruinous state, that nothing but the stones, and some iron materials which remain, can ever be converted to any use.

According to Mr. John Grieve's Report,* they originally consisted of a forge with a refining hearth, worked by an overshot water-wheel of sixteen feet in diameter, with three cranks on its axis, working three cylinder bellows, each thirty inches in diameter ; a mumb-ling hammer, about three tons weight, worked by an overshot waterwheel, thirteen feet in diameter and four feet eight inches broad, with air furnaces, &c. &c. for puddling. A slitting mill with two overshot water-wheels of twenty feet in diameter and four feet and a half broad. The rollers and cutters were each thirteen inches in diameter.

There are two houses for managers, in tole-

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* See Appendix, No. 1.

nable repair, belonging to the works, and some houses for workmen.

From what has been said it appears, that the only part of the Arigna works, which are immediately available for any useful purpose, consists of the upper works. If the mill-race already proposed were completed, a very moderate sum would be sufficient to fit the blast furnace for immediate work.

OF THE PRICES, AT WHICH THE DIFFERENT MATERIALS CAN BE DELIVERED AT THE WORKS.

The ingredients necessary for smelting iron consist of clay ironstone or iron ore, coal, limestone, and moulding sand.

In describing the stratification of the different divisions of the Connaught coal district, the probable quantities of the two principal ingredients, namely ironstone and coal, contained in each, have already been mentioned; but the means and price, at which these could be delivered at the works, remain still to be considered.

During the time that iron was made at Arigna the works were supplied with coal from Aughabehy colliery in the southern division of the district. The distance between the colliery and the works is two miles, and the outgoing of the coal is about five hundred feet above the

furnace bank at Arigna. A road has been made with a tolerably regular descent from the colliery to the works.

Formerly the greater part of the coal was carried on horses' backs, and cost, according to Mr. Grieve's Report, for carriage, three shillings and four pence per ton of twenty hundred weight. Should the works be recommenced, a railway may be laid on this road, altered in some places so as to preserve a more regular descent. This would reduce the price of carriage, from the colliery to the works, to three pence or four pence per ton.

If the coal from the Rover colliery were found to be of equal quality with that from Aughabehy, a short connecting railway might be laid from it to join that already proposed.

The price formerly paid for raising the coal, including royalty and all contingencies, was five shillings a ton, which, with the price of carriage, amounted to eight shillings and four pence per ton at the furnace bank. During the last working a contract was made by a competent person* to deliver the coal at the works for seven shillings and six pence a ton.

If the general system of working and drawing out the coal, recommended in this Report, were adopted, and if railways were laid from the colliery to the works, there is little doubt

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* Mr. Colthard.

that coal might be delivered at the works under four shillings a ton.

The quality of the coal, as it relates to the making of iron, is excellent. According to the analysis of Mr. Kirwan, 100 parts of this coal are composed of

Carbon,	71.42	} Specific gravity 1.351.
Bitumen,	23.37	
Grey ashes,	5.21	
100.		

In coaking on a large scale, thirty-two hundred weight of the coal were found to yield twenty hundred weight of coak of excellent quality. The coak was made in the open air, by which some loss was sustained.*

OF THE IRONSTONE.

Numberless beds of clay ironstone occur throughout the Connaught coal district, interstratified with the great bed of slate clay already mentioned, which varies from three to five hundred feet in thickness. From the constant decomposition of this slate clay, immense quantities of the ironstone are annually de-

* This is the general method practised at the English and Scotch iron works. Were large coaking ovens built, the expense of erecting them would soon be repaid by the saving in fuel.

tached from the beds, and are found in the channels of the different rivers and streams.

Whilst the blast furnace continued to work at Arigna, it was almost entirely supplied with ironstone collected from the streams by the inhabitants, who delivered it at the works for three shillings and four pence per ton. But had it continued at work for any considerable length of time, this casual supply could not have been sufficient; and recourse must then have been had to the clay ironstone beds, which are in general thin and difficult to work. In this case the average expense of ironstone, when delivered at Arigna, would probably have increased to five or six shillings a ton.

Many very rich and moderately thick beds of clay ironstone are visible in the bed of the Arigna, particularly at the mill and at Altagowlan. At this place some trivial workings have already been made on two of the richest beds. Clay ironstone also abounds at the base of the Slieve an nirin mountains, on the east side of Lough Allen.

There is a great difference in the quality of the ironstone contained in the different beds; that at Altagowlan is among the richest.

OF THE LIMESTONE.

The Arigna iron works are very favourably circumstanced with respect to limestone, the third substance necessary for smelting iron. The nearest quarry is half a mile north of Kea-duc, about one mile and a half distant from the works. The quality of the limestone is excellent. The present road from the quarry to the works is extremely ill laid out; it has been carried over a mountain of so steep an ascent that the whole of the limestone was necessarily carried from the quarry on horses' backs at the expense of four shillings per ton. If a proper road had been made in the valley at the base of the hills, it might easily have been raised and delivered at the works for two shillings a ton.

There is abundance of excellent moulding sand at Knockcranny, three miles distant from the works, and one mile beyond the limestone quarry. If the new road were made, it might be delivered at the works for two shillings and six pence per ton.

It thus appears that in the vicinity of Arigna ironworks there is abundance of coal, ironstone, and limestone, all of which can be delivered at the works at a moderate rate. We shall next consider the price, at which pig iron could have been made at Arigna by the first

company, and contrast it with the probable expense for which it could now be made, were the proposed improvements carried into effect.

Expense of making a ton of pig iron, calculated from the cost of the different materials, when delivered at the works during the time of the first working :

	£.	s.	d.
Five tons of raw coal at 7s. 6d. per	1	7	6
Four tons of ironstone at 3s. 4d. per	0	13	4
One ton of limestone	0	4	0
Expense of coaking, roasting, furnace-men, &c. &c.	0	10	0
	2	14	10
Contingencies at 20 per cent.	0	10	7½
	3	5	5½

Expense at which a ton of pig iron could now be made, were the proposed improvements carried into effect :

	£.	s.	d.
Five tons of raw coal at 4s. per	1	0	0
ton			

	£	s.	d.
Brought over	1	0	0
Four tons of clay ironstone* at 5s.			
per	1	0	0
One ton of limestone	0	2	0
Expense of coaking, roasting the ore, furnace-men, &c. &c.	0	10	0
	2	12	0
Contingencies for timber, iron, wear and tear of furnace, machi- nery, &c. &c. at 20 per cent.	0	10	5
Total expenset	3	2	5

It would appear at first sight, from the foregoing statements, that there would be only an increased profit of three shillings per ton on pig iron, when the proposed improvements are finished, over and above the expense according to the first working. But this is not the case ;

* The expense, of a ton of ironstone in this estimate is calculated on the supposition that the works are to be supplied from beds of ironstone worked for the purpose, and not depending, as in the first working, on the ironstone collected from the streams.

† The expense, at which the different materials may be delivered at the works, is given from my own calculation. The quantities of coal, ironstone, and limestone, used in smelting one ton of pig iron, are ascertained partly from information collected from furnace men still resident at the works, and partly from the excellent Reports on the Arigna works by Messrs. Grieve and Guest. See Appendix, No. 1 and 2.

for the expense of raising ironstone for the new working is calculated at five shillings instead of three shillings and four pence per ton. Could ironstone be always afforded at the works at three shillings and four pence per ton, there would be a profit in the new works, above the old, of nine shillings and eight pence per ton ; but unfortunately this cannot be expected, as all the loose ironstone would soon be collected from the streams, and then the only resource would be in working the beds.

These calculations are confined to the expense of manufacturing pig iron. Should the iron be re-melted, and cast into small articles, the diminution in the price of coal will greatly increase the profit ; and if, as the works proceed, it were found advisable again to make bar iron,* the cheapness of coal will prove a great additional saving in the expense of the manufacture, and a proportionate increase of profit to the company.

OF THE DIFFERENT MARKETS FOR COAL AND IRON.

The situation, extent, and quality of the different beds of coal, contained in the Con-

* Those who wish for particular information, as to the probable expense of each stage in the manufacture of bar iron at Arigna, will find a very satisfactory estimate of it towards the conclusion of Mr. Guest's Report. See Appendix, No. 2.

naught coal district, have already been considered; as also the probable expense, at which coal might be raised and pig iron made at the Arigna iron works. Our next consideration will be how to dispose of these commodities at such a price, and in such quantities, as will fairly repay those who may hazard their properties in such speculations.

The markets may be divided into two classes; those of the neighbourhood, which must be supplied by land carriage, and those at a distance, which are available by means of the river Shannon and the Grand and Royal canals.

The neighbouring markets consist of the towns of Sligo, Boyle, Cavan, and Belturbet, and the whole country between them and the coal district.

The bogs in the vicinity of Sligo are now nearly cut out, and that town is at present supplied with coal from Scotland, at an average rate of about forty shillings a ton.

It would appear from the custom-house books, that 5,000 tons of coal are annually imported into Sligo, the whole of which is consumed in the town and its immediate vicinity.

The town of Boyle is at present well supplied with turf; no immediate demand for coal in quantity can reasonably be expected there.

The towns of Cavan and Belturbet are situated in a country in the utmost distress for fuel. The small bogs, from which the inhabit-

ants have hitherto been supplied, are now so nearly exhausted, that turf sells at an enormous price. The expense is so great, that many persons find it cheaper to draw English coal landed at Drogheda, a distance of thirty-five miles; and others, at the risk of destroying their horses and carts from the badness of the roads, have lately sent for coal to Aughabehy colliery in the southern division of the district. This is the only colliery at present at work, and, as has already been stated, not more than twenty tons per week are raised from it.

The English coal, when delivered at Cavan, costs three pounds per ton, that is, twenty-five shillings per ton at the ship, and thirty-five shillings a ton for carriage.

If coal could be laid down at Cavan for thirty-five shillings per ton, the county of Cavan would consume at least fifteen thousand tons a year.

The DISTANT MARKETS for coal consist of the numerous towns and immense extent of country on the banks of the river Shannon, and on the Grand and Royal canals. The Shannon market ends at Limerick, and that of the canals at Dublin.

It must not be supposed, that either of these cities will be wholly supplied with coal from the Connaught district. The freight of coal from Whitehaven to Dublin will, at all times, be less than from our own collieries by means

of the navigation of the Shannon and canals. But in the event of a long continuance of adverse winds, the arrival of our own coal will tend to lessen the price both in Dublin and Limerick, particularly in the latter.

OF THE PRESENT STATE, AND REQUISITE IMPROVEMENTS IN THE NAVIGATIONS.

From what has been said it would appear that the country contains ample markets to consume our coal, if it can be delivered at a moderate price; but at present this is impossible. There are no passable roads to any of the collieries, and the navigation of the Shannon has been completed no farther than the entrance to Lough Ree.

The Directors General of inland navigation in Ireland are at present most actively employed in completing the Royal canal, to the river Shannon at Tarmonbarry; and it is generally understood that, as soon as it is finished, they will proceed to improve the navigation of the Shannon between Tarmonbarry and Lough Allen; and by this means encourage the recommencement of the Arigna iron works, and the working of the collieries.*

* Since this Report was written the canal has been completed, and a grant of £15,000 was made the last session of Parliament for completing the navigation of the Shannon above Battle Bridge.

When the navigation shall have been completed, the iron rail way, already proposed to be laid from Aughabehy colliery to the iron works, may be continued down to the lake, from whence both coal and cast iron may be shipped for Dublin, Limerick, &c.

In calculating the expense of making a ton of pig iron, it has already been stated, that coal can be delivered at the iron works for four shillings a ton. The encreased expense of drawing it on the rail way, from the iron works to Lough Allen, will be very trifling. But to cover the expense of wear and tear of horses, waggons, railways, &c. we may calculate that the coal company, without any profit to themselves, could ship the coal at Lough Allen for four shillings and four-pence a ton. If to this we add the sum of three shillings and eight-pence per ton, as an allowance for profit, and to cover contingencies, it would appear that coal could be sold at Lough Allen for eight shillings a ton. To this let us add the freight to Dublin by the Shannon and canal, a length of about 85 miles, at three-pence per ton per mile, that is, one penny per ton per mile toll, and two-pence per ton per mile freight to the boat owner; coal could, therefore, be sold in Dublin at the rate of £1 5s. 6d. per ton. The distance between Lough Allen and Limerick, by the course of the Shannon, is about 83 miles, and consequently, at the rate of two-pence half-penny per ton per mile, the cost of

coal at Limerick would be under one guinea per ton.

But the navigation of the Shannon, particularly in Lough Ree and Lough Derg, is less certain than that by the canal where the boats are drawn by horses, and not subject to be delayed by contrary winds. This evil might be remedied by using steam boats on the lakes, (or perhaps for the whole length of the Shannon,) to draw* on the boats loaded with coal. Three coal boats might be drawn at a time by one steam boat, two tied in length, the stem of one to the stern of the other, and a third placed on one side, and fastened to both in such a manner, that its centre should be exactly opposite the joining of the two placed lengthwise. One steersman in the middle boat might steer the three.†

* Steam carriages are now much in use, particularly in the north of England, for drawing coals on railways. In this case the steam carriage is separate from the coal waggons, which are drawn after it in a long line, usually consisting of from fifteen to twenty.

A steam engine, of the power of from four to six horses, might be placed in a boat of such a size, that its breadth, together with that of the propelling wheels on the outside, should not exceed twelve feet. There would be no difficulty in passing this boat through the different locks and bridges on the navigation of the Shannon.

† On the Duke of Bridgewater's canal coal boats are drawn united in this manner, between Worsley mill and Manchester.

OF THE ROADS.

The whole of the coal, which occurs in the Connaught coal district, is found in very elevated situations, when compared with the general level of the country. For this reason much skill is requisite in selecting the most eligible lines of road from the collieries to the neighbouring great towns.

The coal in the southern and western divisions of the coal district is by much the best and most valuable in the country: we shall therefore direct our principal attention to easy communications between these divisions and the neighbouring country. At present there is no direct road, at least none deserving that name, from either of these divisions to any town in the country. The town of Sligo, in a straight line, is but 14 miles distant from Aughabehy colliery, and the present road, round by the ironworks, is 22 miles in length. The best mode of communication between the collieries and the town of Sligo will be to make a new road from Aughabehy colliery, running under Geeva point, and from thence descending gradually through the parish of Killenunnery to the head of Lough Gill, half a mile below the village of Drumahair. A branch from this road can be made from Geeva to the Mounterkenny collieries. The whole length of the proposed road between Augha-

behy and the head of Lough Gill could not much exceed nine miles. When finished, coals might be drawn on it in carts, and shipped at the head of the lake into large boats for Sligo, a distance of about seven miles and a half. By this means coals could be sold at Sligo for seventeen shillings a ton; that is, seven shillings and six-pence a ton at the colliery, five shillings a ton land carriage to Lough Gill, two shillings and six-pence a ton freight and unloading at Sligo, and two shillings a ton allowance for loss of carriage, expense of storage, and profit to the coal merchant.

But even suppose a greater price than seven shillings and sixpence a ton were extorted at the colliery, still, with every allowance, excellent Irish coal could be sold in Sligo at twenty shillings a ton.

At present, as already observed, the inhabitants pay, on an average, thirty-five shillings, and frequently two guineas a ton for English coal. A line of canal was many years since laid out* to connect Lough Allen with Lough Gill, by following the valley of the river Bonnet; but, on account of the number of locks, the expense of this navigation would be very considerable.

To communicate with the counties of Roscommon, south of Leitrim, and Cavan, the coal should be drawn down the railway already men-

* The survey and levels were taken by Mr. Larkin.

tioned, to a depôt near Lough Allen, from whence, by slight improvements in the existing lines of road, particularly at the extremities nearest to Lough Allen, easy communications could be opened with the adjoining country.

Coal, as already stated, could be sold at the depôt at eight shillings a ton; and, calculating the expense of land carriage at the rate of eleven-pence per ton per mile, the price it would cost the consumer may easily be ascertained. According to this scale the price of coals at Cavan, which is 23 miles distant from the proposed depôt, would be twenty-nine or thirty shillings per ton.

To connect the coal field of the western division with the depôt, either a new line of road or a railway will be requisite.

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To connect the coal field of the western division with the depot, either a new line of road or a railway will be requisite.

APPENDIX.

No. I.

*Report of the Arigna Iron Works, &c. May,
1800.*

THESE works are situated in the county of Roscommon, on the west side of Lough Allen, and within a mile of it; they are on the west side of the river Arigna, and at the south end of the mountain called Brahlieve, which abounds with iron-stone, coal, and lime-stone. There are other mountains in that neighbourhood, which also abound in these minerals, viz. the Cockra mountain, between the river Arigna and Lough Allen; the Iron mountain on the east side of Lough Allen, and the Dobally mountains at the head or north end of that lough.

In former times numbers of Bloomeries have been erected on each of those mountains, and these Bloomeries were continued till all the wood in the country was worked up; the last of them was at Drumshambo, at the south end of Lough Allen, and some people are yet alive who remember to have seen it at work. These Bloomeries were worked entirely with charcoal; for it was not at that time known, that iron, either cast or malleable, could be produced by means of pit coal: they worked upon no other mine but the iron stone from the mountains. The quarry of iron ore at Drummond, on the river Shannon, twelve miles below where this river issues out

of Lough Allen, does not seem to have been then known, or, if it was, they had not found it to improve the quality of their iron, and they could not want it for any other purpose; such was their abundance of iron stone.

About eleven years ago, after it had been ascertained that cast and malleable iron could be produced by means of pit coal, the present iron works at Arigna were erected immediately on the west side of that river, at a place where there had been a slitting mill for some of the old Bloomeries.

These works are on an extensive scale, and well executed; they are divided into upper and lower works.

THE UPPER WORKS ARE,

- I. A blast furnace, forty-four feet high, and twelve feet wide at the bosh. The furnace bank descends to the bridge-house and tunnel head; so that the materials are thrown into the furnace out of wheel-barrows. An overshot wheel of twenty-seven feet diameter blows this furnace, and also works.
- II. A very good boring mill.
- III. A foundery with two cupolas, and room for a third cupola; with a complete set of patterns, potting-shops, and warehouses.

There is also at these upper works a horse mill for grinding fire clay by a stone on edge.

THE LOWER WORKS ARE,

- IV. A forge with a refining hearth, worked by an overshot water wheel, of sixteen feet diameter, with three cranks on its axis, working three cylinder bellows, each of thirty inches diameter; and with a mumbling hammer of about three tons weight, worked by an overshot water-wheel of thirteen feet diameter, and four feet eight inches broad; with air furnaces, &c. for puddling.

V. A slitting mill, with two overshot water-wheels of twenty feet diameter, and four and a half feet broad each, rollers and cutters, each thirteen inches diameter.

And there is at these lower works a mill for grinding sad irons, and another for grinding blacking for the moulders; and there are two excellent houses for managers, and many very good houses for workmen.

The lower works, till of late, were supplied only with the water, which came from the upper works, and this was merely a few of the droppings from the east side of the Brahlieve mountain; but lately a dam has been made at a considerable expense across the Arigna, to wear this river into these lower works, and after this the lower works cannot be in want of water.

The droppings from Brahlieve were so far from supplying water to the blast furnace, that a double steam engine has been erected on Boulton and Watt's construction; its steam cylinder thirty two inches diameter, not cased; its blowing cylinder five feet four inches diameter, to assist the water-wheel in dry times. This fire engine has been erected at a great expense, and there was a great daily expense in maintaining it. It would have been much better, and still it will be proper to bring the Arigna into the furnace pool, that there may be always a sufficiency of water to blow the furnace, without having occasion to use the fire engine. On the furnace bank are three draw-kilns for calcining the iron stone; the surface of the water-lead may be taken on a level with the top of these calcining kilns; may be carried in the ground around the west side of the furnace pool, and then along the east side of the Brahlieve mountain, till it reach the Arigna, across which the dam to be made may be very inconsiderable. This level water-lead will serve the double purpose of conveying materials as well as water to the works. Hitherto the difficulty of conveying materials to the works has been excessive; the colliery is on the east side of Brahlieve, two miles distant from the works, and about eighty fathoms perpendicularly above them; and of the different methods they tried for bringing home the coals the preferable one was found to be on horses' backs. A horse carried three cwt. at

a time; he went two rakes in winter, and three in summer, average two and a half loads of three cwt. seven and a half cwt. a day, forty-five cwt. a week. In this way the furnace would require sixty horses to supply it with coals alone, and reckoning each horse and its driver to earn only one shilling and three-pence a day, the collier's ton of thirty two cwt. would cost in leading five shillings and four-pence. Add to this, when the goods were made, they could not be got to the principal market, Dublin, under a land carriage of eighty-four miles, which in this country costs one shilling per ton per mile, and this amounted to a prohibition, particularly on pig iron.

Till these difficulties were removed, it would have been better not to have erected these works; and now that they were erected, it was reckoned expedient, about two years ago, to put a temporary stop to them. This stoppage need not be long—the Grand Canal Company are obliged, under a penalty, to join their canal to the Shannon by the end of 1803: their nearest junction is at Athlone, fifty-five miles from Dublin. From Athlone the navigation up the Shannon to Arigna is forty miles, thirty-four of which are already passable for small craft of ten tons, and it is now under the contemplation of Parliament to deepen this part, and to make the remaining six miles navigable. In all 95 miles.

And reckoning this, even at two-pence per ton per mile, the carriage from Arigna to Dublin will be under sixteen shillings a ton; and when the water-lead from the Arigna to the furnace-bank shall be finished, materials may also be carried on it for two-pence a ton per mile.

The coal which they were working on Brahlieve, two miles north from the furnace, was only twenty-seven inches thick at the outburst, where they began to it, but, having driven eighty yards to the dip of their deepest or water drawing pit, it gradually thickened, so that at the end of these eighty yards it is three feet thick, including one and an half inch of black slate. The coal dips into the hill one in twelve. On the other side of the mountain, and about a mile distant, Mr. Tennison is working the same seam of coal, dipping also into the mountain; it is therefore what is called a swilly or trough

coal, and in the swilly the coal will be found to be very flat, and considerably thicker than it is elsewhere. The Brahlieve coal was wrought in the long way; the colliers were paid from four-pence to six-pence for holing a square yard; but latterly they were paid by the collier's ton, from one shilling and four-pence to one shilling and ten-pence.

A collier's ton is thirty-two heaped bushels; each bushel eighteen and a half inches diameter, and eight inches deep; weighs, when heaped, one cwt. of coals; a collier's ton is therefore thirty-two cwt. and say it

	£.	s.	d.
cost for holing	0	1	10
One man employed to break the coals	s.	d.	
at the wallfaces, at per day	1	8	
One man for filling ditto	1	1	
For five tons	2	9	per ton 0 0 6½
Two boys to draw these from wall- faces to barrow-road at eight-pence each	1	4	0 0 3½
Two barrow-men to wheel them to bottom, at 1s. 1d.	2	2	0 0 5
One pit bottom boy	0	8	
One gin boy	0	8	
One banksman	1	1	
For ten collier's tons	2	5	0 0 3
Two gin horses belonging to the pro- prietor, suppose 3s. a day, each on ten tons,			0 0 7
One man constantly employed in quarrying freestones for the build- ings in the long way of working,	1	4	
One carter to lead these stones	0	10	
One cart horse	3	0	
On twenty tons, or two pits work	5	2	0 0 3
Carried forward			0 4 2

	s.	d.	£.	s.	d.
Amount brought over			0	4	2
One smith for sharpening colliers' picks and shoeing horses, per week	6	0			
One carpenter, three days a week, re- pairing barrows, slipes, gin, &c. at 1s. 6d. per day	4	6			
On a 120 colliers' tons	10	6	0	0	1
There was an expense of drawing water, ten yards from the bottom of the pit to the upper level, two horses, one by night and one by day, per week	22	0			
Two men at 1s. 1d. per day each	1	2			
Two boys at 8d. per day each	9	4			
On 120 tons	66	6	0	0	7
And there was 2s. 8½d. a yard for making in the barrow-road four and a half feet high—breast 20 yards on each side—40 yards, by 1 yard in—20 colliers' tons			0	0	2
Upholding gins, gin ropes, slipes, and bar- rows,			0	0	3
Sinking pits and running levels			0	0	9
Expense of raising a collier's ton			0	6	0
Lordship paid to Mr. Tennison, the ground owner, 2s. per ton, but no lordship paid to him on iron stone or lime stone, and no ground da- mages paid to him—the lease from him perpe- tual			0	2	0
Carried forward			0	8	0

	£.	s.	d.
Amount brought forward	0	8	0
Carriage of a collier's ton from the pits to the furnace-bank, as per 5th of this,	0	5	4

8s. 4d. per 20 cwt. 0 13 4

So the coals cost, laid on the furnace-bank, 13s. 4d. a collier's ton of 32 cwt. and this collier's ton, when coaked, yielded 20 cwt. of coaks. The seam yielded 2-3ds great coal and 1-3d small, but this small was also coaked, and, when kept free of slate, its coak did as well for the furnace as the coak of the great coal; but the expense of coaking it was greater, for in place of open hearths it had to be coaked in small ovens, each holding a collier's ton.

The quality of this coal is much like that of the coal at the iron-works in South Wales; it has little flame and little smoke, is ill to kindle, and burns to a white ash.

A level was begun to be carried into this colliery from the west side of the Arigna, and about 30 fathoms perpendicularly above it: this level is within 90 yards of the water drawing pit, and it will have 80 yards further to go to be at the wall-faces. It is, however, proper to drive in these 170 yards, and to continue it always before the workings. This level is 5 feet high and 4 feet wide: it was customary to take the deeds out of it in boats, and it will be proper also to boat the coals out by it. It is about 30 perpendicular fathoms below the present wall-faces; so, instead of ginning up the coals as formerly, they will be to let down these 30 fathoms by a roller and curb, which is a much easier and cheaper operation; but in order to render the level convenient for this purpose, it ought to be cut one and a half or two feet deeper: the additional expense of this is trifling, where the deeds are taken out by boats, and where the prevailing strata of the mountain are black thill. In this way the expense of bringing the coals to the furnace-bank will be lessened at least 5s. 6d. per collier's ton, viz.

	s.	d.
Gin horses and boy,	0	8
Drawing water,	0	7

The expense of leading the coals from the level s. d.

mouth to the furnace will be 1s. 1d. per ton,

viz. 2d. a ton per mile on the canal—2 miles

—4d. a ton of 20 cwt. per collier's ton, 0 6½

There will be a descent from the level's mouth

to the level water lead, of about 30 perpendi-

cular fathoms, suppose it require as much

to let the coals down this descent, . . . 0 6½

1 1 1 3

There will in this case be a saving in leading of

(page 86) 4 3

Saving per collier's ton, 5 6

And per ton of 20 cwt. 3 5

And the cost of delivering a ton of 20 cwt. on
the furnace-bank will be (page 89) . . . 4 11

The ironstone was wrought by the tenants and country people, and led by them to the furnace bank for 2½d. per cwt. of 120lb. in full of every expense, and they gave one to the score as usual. This amounts to 3s. 8d. for 20 cwt. of 112lb.

There will in future be a saving on the iron-stone, that will be boated along the water-lead to the calcining kiln-heads, in as much as it is cheaper to carry it in that way than on horses' backs.

The limestone was also carried on horses' backs, and laid down on the furnace bank for 2s. 6d. per 21 cwt. of 120lb. and this is equal to 2s. 3d. for 20 cwt. of 112lb.

The pig-iron, which was made at Arigna, was excellent for castings, and it ran into as fine goods as any pig-iron in England. To make the ton of 20 cwt. of it:

5½ tons of raw coals were required, the ton be- £. s. d.
ing 20 cwt. of 112lb. averd. these at 4s. 11d.
a ton, as above mentioned, amount to . 1 7

	£.	s.	d.
Brought forward	1	7	0
4 of said tons of raw iron-stone were required, and these at 3s. 8d. is	0	14	8
23 cwt. of lime-stone was required, this at 2s. 3d. the said ton, is	0	2	7

Cost of a ton of pig-iron in materials, 2 4 3

The price paid in Shropshire to undertakers, who calcine the materials, work the furnace and the blowing fire engine, is 7s. a ton of 20 cwt. of pig-iron. This will be as cheaply performed at Arigna, where wages are lower, and where there will be only water machinery; but call it the same, 7s. English is 0 7 7

The ton of pig-iron will then cost at Arigna,
(Irish) 2 11 10

or (English) 2 8 0

Which includes every expense except that of small coal for calcining iron-stone, for which purpose the broke of the great coal is generally taken; but put for this, and for upholding the tare and wear of the machinery, 0 12 0

Total cost of making a ton of pig-iron, 3 0 0

The iron produced at Arigna is so soft that, unless some of the Drummond ore were mixed with the iron-stone, there will probably be a great waste in converting the pig-iron into malleable iron. From what was done formerly it was said, that 35 cwt. of pig-iron was required for making 20 cwt. of rod-iron. Even if this waste cannot be lessened, by using a mixture of the Drummond ore, or by using peat earth, with which the country abounds, in some part of the refining process, still rod-iron could be made to great advantage; but until another blast-furnace be erected, for which the level water-lead will bring a sufficiency of blowing power, there is not likely, over what will be required for castings, to be much pig-iron to spare for the forge or slitting mill.

The average produce of the furnace at Arigna is estimated at one thousand tons of pig-iron yearly ; and considering the ten shillings a ton duty on iron imported into Ireland, which duty is to be continued after the Union, a ton of pig-iron at Arigna may be valued at £8 sterling. This is a moderate price for pig-iron fit for castings ; and as there is already on the spot machinery for converting the pig iron, that may not be fit for castings, into bar iron and nail rods, the whole of the one thousand tons a year may very well be rated at £8 a ton ; and when we deduct the £3 cost of making a ton of pig iron, (page 91) there will remain £5000 a year profit of the Arigna works, when only the present furnace is employed ; but on erecting another furnace the profit will be somewhat more than doubled, as working one furnace is attended with nearly the same fixed expense as working two.

The limestone and ironstone at Arigna are of the best quality, and inexhaustible. The coal is not yet discovered in such plenty ; the thickest seam of it they have yet met with is only three feet, and this is on the Brahlieve mountain, on which the works are situated. Four square miles of this coal have been traced, and, as one square mile of it will supply a furnace about five hundred years, there cannot be said to be a scarcity.

But though no seam of coal has yet been discovered thicker than three feet on Brahlieve, or on the adjacent mountain, Cockra, to which the canal or water-lead will also reach, it is likely thicker seams may be discovered on them ; for there has been discovered on the neighbouring mountains, at Dowbally, a seam said to be ten feet thick.

JOHN GRIEVE.

APPENDIX, No. II.

Report of the Arigna Iron Works, by Thomas Guest, October, 1804.

THESE works are situated in the county of Roscommon, on the west side of Lough Allen, and within about a mile of it; they are on the west side of the river Arigna, and at the south end of the mountain called Brahlieve, agreeable to the description I had been given thereof; on which mountain are several veins of ironstone already open at the distance of about a mile from the works; but the principal veins or strata which I saw were by the side of the river, and had been lately worked by the inhabitants; there are three strata of ironstone at a place called Altagowlan, on the east side of Arigna, that may be worked to advantage, being, as I was informed, on the same lordship; yet, as they lie at the distance of about two miles from the works, the expense of carriage will be greater in proportion. There are also other strata near the top or south end of the mountain (Brahlieve) above the works, and I doubt not but others may be found near the works. A very considerable quantity of ironstone may also be raised at the Iron mountain on the east side of Lough Allen, (from whence, it seems most probable, the charcoal furnace, which has been carried on near Drumshambo, must have been supplied) and from the distance, I estimate the expense of raising and carriage to Arigna will be about 7s. 6d. per ton. The ironstone has hitherto been raised and delivered at the furnace by the tenants, at 3s. 8d. per ton of 20 hundred weight of 112 pounds; but when an extra

quantity comes to be wanted, and the consumption regular, a greater quantity of mine works must be opened, levels drove, and roads made, the iron-stone will cost nearly double the present price, say 6s. per ton, in a short period of time.

There is only one vein of coal yet found on this mountain, which has been tried to make iron with, and whether there is any other or not is yet uncertain; it has been raised at a place called Aughabehe, by means of pits without a level, some of which are now open, but are so full of water as to prevent them from being worked. A level has also been drove at a very considerable depth below the vein, the distance of about two hundred yards; this level, it is said, is within ninety yards of the water-drawing pit, but, from being injudiciously done, part of it is fallen in; it is at present full of water and rubbish, and it is doubtful whether it will ever be rendered serviceable, at least not for many years, as, if drove to the extent, it would be about seven hundred yards beyond the water pit: upon the whole, it will be necessary to drive a new level at a less depth below the vein, so as to strike the vein about eighty yards beyond the present working; which will gain sufficient breadth for the present, and by driving the same under the water-drawing pit, and boring from thence to the level the water may be let out of the present colliery, and the old works carried on farther: the expense of driving this new level, I estimate to be about 5 or 600*l*. and, by laying dram plates therein, the coal may be brought out without the expense of winding up pits. Not having seen any of this coal, I can say nothing with respect to its quality; but, as an indication of its goodness, I saw some good grey melting iron at the works, which was made therefrom. There are also two pits lately sunk upon the Brahlieve mountain, at a place called the Rover; the second pit was sunk upon a fault. The vein, when first discovered at the bottom of the pit, was not two feet thick, but, on drifting to the deep a few yards, it increased to two feet three and a half inches, which work at present yields very little water. This vein may probably turn out to be the same as that at Aughabehe, notwithstanding it at present deeps in a contrary direction.

It is adviseable to drive a level to this coal also, as it would be highly imprudent to have a work dependant on one level; for, should any accident happen by a fall on the road, &c. the whole works may be put to a stand; when, if there were two or three levels, it may be supplied while the other is repairing, and the coal may be then brought out as described for the Aughabehe colliery. With respect to this coal, about two thirds of it may be coked in the open air: but, as the other part is quite small, it will be necessary to have a quantity of ovens to coke it in; and even then this small coal, being mixed with slate, will not be of so good a quality or so fit for the furnace as the other; which I understood was the case with Aughabehe coal. I have seen some of the Rover coal coked and used in the cupelo; it melted the iron very quick and well, which I consider is a symptom of its good quality; and, from what I could judge, have little reason to doubt its answering the purpose of making iron, especially that part of it which can be coked in the open air. The cost of raising this coal, and delivering it at the furnace-bank, I estimate at 6s. 4d, per ton.

The limestone, being at the distance of two miles, has formerly been carried and delivered at the furnace at 2s. 3d. per ton; the price of carriage of which may probably advance as the consumption becomes regular and the provender scarcer to keep horses in the winter. Sand lies at a still greater distance, costs at present 5s. per ton, and will be subject to the like inconvenience to get it carried. Having stated the situation of the ironstone, coal, limestone, and sand, I have now to say, that the works consist of a blast furnace, forty-four feet high, twelve feet wide on the bosh: the furnace bank being nearly level with the bridge-house and tunnel-head, the materials have been thrown into the furnace out of wheel-barrows; upon which bank there are three kilns for calcining the ore previous to its being thrown into the furnace. The furnace has been blown by an over-shot water-wheel, twenty-six feet diameter, and two cast iron cylinders, seven feet diameter, worked by cams upon the pistons with poisebeams. To the other end of the shaft is fixed the boring-

mill. The water hitherto used, being only the droppings from Brahlieve mountain, having been found insufficient, a double steam engine has been erected on Bolton and Watt's construction, its steam cylinder thirty-two inches diameter, not cased, its blowing cylinder five feet four inches, to assist the water-wheel, but, having been injudiciously completed, is now quite out of repair, and, the beams being broke, it will require a new one before it can again be put to work; and I apprehend there must be a new air-pump and condenser, the present ones being too small in proportion to the size of the cylinder; and supposing the engine in complete repair, the expense of coal to work it, oil, hemp, grease, wear and tear, and labour, would be excessive. It will therefore be adviseable to cut a new level to bring the Arigna water into the furnace pool, which, by the best information I could get, will be more than sufficient to work two furnaces. The expense of doing this, I presume, will be about £1000. The water thus brought, by widening the sole of the water-wheel, and adding some cog-wheels and a fly thereto, I think may be so contrived with the present blowing cylinders, by putting piston-rods and casting tops to them; taking away the poise-beams, and working with a crank a double stroke, to blow a sufficient quantity of blast for two furnaces; in which case three more mine-kilns should be erected, and another furnace. The building of the boring-mill may answer the purpose for part of the casthouse, and the boring-mill attached to some other part of the premises. There is also a foundery with two cupelos, potting-shops, and warehouses for casting small castings; and in the casthouse there is a crane and an air-furnace for the purpose of making large castings; these are tolerably well adapted for carrying on the casting business. There is also a horse-mill for grinding clay by the old method of stone on edge, and a kiln erected for burning brick. This kiln is much too small, and the drying-room must be altered into a stove, to make brick in all weathers.

THE LOWER WORKS

Are, a pond calculated to receive the water from the tail of the furnace-wheel, below which there is a forge where has been a refining hearth worked by an overshot wheel of sixteen feet diameter, with three cranks on its axis working three cylinder bellows, each thirty inches in diameter; where has also been a shingling hammer worked by an overshot wheel of thirteen feet diameter, four feet eight inches broad, and two air-furnaces, the one having been used as a puddling-furnace, the other as an air-chaffery, the stacks of which only are remaining.

A slitting mill, where has been two overshot water wheels of twenty two feet diameter. There is one pair of rolls and cutters; the cog-wheels being made of wood with wooden cogs, from the length of time since they have been worked, must be nearly decayed. The water-wheels are all down except one; and this one, from being exposed to the weather and not being used, can be little better, the shafts only appearing to be good. This forge is ill adapted to the present improved method of making bar iron; as such, very few if any of the shafts will come into use.

There are also some workmen's houses, and two houses for agents, the largest of which is too small for a man who has a family, there being only two small parlours, a kitchen, and three bed-rooms; the situation thereof is also extremely bad; being built upon a level with the coke-yard, it will be at times so annoyed by the smoke from the coke-hearths and works, that it will be hardly possible to live in it. I would therefore recommend a house for the manager of those works to be built on the flat meadow on the other side of the Arigna. The bridge over the river being repaired, he would then be very near the works; and, by putting the front of the house towards the works, he would have a view of what was going forward at all times.

I have now to take notice of the present buildings, machi-

nery, clerks' and workmen's houses, &c. &c. (exclusive of the stock of ironstone, coal, and limestone and other articles, as tools, &c.) with the valuation thereof; which I set down at £20,000. The expense of making it a complete work, viz. cutting the water-course from the Arigna to the furnace-pool, altering the blowing machine, widening the sole of the wheel, and putting iron ladles on, making and fixing a large cog-wheel of iron on the shaft with two other iron shafts and cog-wheels to work a fly-wheel, timber for framing, cast iron for standards and riders, &c. iron for bolts, widening the present wheel-pit, and altering the fly wheel-pit, a crank with two cast iron lever beams to work the pistons, piston rods (turned), cast iron tops to the present cylinders, with air-boxes and pipes to carry the blast, with pins, bolts, &c. building three mine-kilns, a new furnace, bridgehouse, coke-ovens, driving levels to the collieries, opening coal and mine works, making roads, drilling blocks of stone to lay the rails upon, dram rails, drams with wrought iron axles and cast iron wheels to carry the coal and ironstone to the works; coke-barrows, wheel-barrows, and cast iron wheeling-plates, to wheel the rubbish from the mine works, colliers' and miners' tools, tools of all kinds for the founders, fillers, cokers, barrow-fillers, mine-burners, bridge-stockers, cinder-wheelers, &c. &c. with a stock of ironstone, coal, and limestone to begin, for the upper works:

AND FOR THE LOWER WORKS

Making fineries, puddling-furnaces, bloom-furnaces, new water-wheels, cog-wheels and fly-wheels, beds, standards, spindles, nutts, coupling boxes, different sets of rolls for rolling iron, cast iron plates for the floors, a planishing forge, boring-mill and mill for turning rolls, with tools and implements for making bar iron, boiler plates, nail rods, or hoops, if the iron, on trial, be found to answer for such purposes, which, if a little more of the coldshort iron ore can be found, I think it may. These expenses, together with a new house

for the manager, and an additional quantity of workmen's houses, will cost nearly £20,000 more.

I must be excused saying any thing respecting the consumption, demand, conveyance, or market; being a stranger thereto, of which you say there is plenty of demand, and the greater part, if not all, would be fetched from the works. This being premised, I have now to say that I have not the least doubt of the works turning out to a good account, as will appear by the following estimates; and to convince you of the reality thereof, I should have no objection to hold a share in the concern.

Estimate of making a ton of pig and bar iron at Arigna.

	£.	s.	d.	£.	s.	d.
5 tons of raw coal, at 6s. 4d. per ton, .	1	11	8			
4 tons of ironstone, at 6s. per ton, .	1	4	0			
1 ton of limestone, at 4s. .	0	4	0			
Working the furnace, calcining, coking,						
&c.	0	10	0			

For timber and wrought iron work
for drams, barrows, tools, nails, steel,
oil, leather, brass, black-lead, grease,
sand, clay, repairs, wear and tear of
machinery, rent, agencies, and other
incidental charges,

	. 1	5	4			
Ton of pig iron, .				4	15	0
24 cwt. of pig iron at 95s. to a ton of finer's metal.	5	14	0			
Refining,	0	3	6			
Cokes, castings, bar iron for tools, wear and tear, &c.	0	10	0			
Ton of finer's metal, .				6	7	6

	£	s.	d.	£	s.	d.
24½ cwt. of finer's metal at 6l. 7s. 6d.						
per ton,	. 7	16	2			
Puddling,	. 0	12	0			
Coal, 2 tons, at 6s. 4d.	. 0	12	8			
Wheeling ashes, weighing charges, rolling, unloading coal, master pud- dler's wages, bricks, sand, clay, re- pairing offices, castings, weighing puddled bars, tools, incidental charges, and wear and tear	. 0	19	2			
Ton of puddled bars,	—	—	—	10	0	0
23½ cwt. of puddled bars, at £10 per ton,	. 11	15	0			
Piling and heating, 3s. 6d. rolling, 3s. 6d.	. 0	7	0			
Coal, 25 cwt. at 6s. 4d. per ton,	. 0	7	11			
Repairing furnaces, sand, brick, cast- ings, streightening, weighing bars and other labour, wear and tear of machinery, grease, and incidental expenses,	. 0	18	1			
Ton of bar iron,				13	8	0

I have now to remark (having been told by one of the iron founders in Dublin) that the price of best foundry dark grey iron is now sold at the works in Scotland at 8l. 5s. per ton, ordinary 7l. 5s. and bright 6l. 5s. from whence the founderies in Dublin get supplied; and supposing the iron could not be sold at the works, I conceive the best method to get it to market would be to carry it to Sligo: the expense of taking it there, weighing and wharfage, would not exceed 15s. per ton. The guide I have for this is as follows: Prior to our having a canal made from Merthyr to Cardiff, we were in the habit of carrying our iron on horses' backs over the hills, being the distance of twenty-four miles, for 13s. per ton; and, if I am rightly informed, the distance from Arigna to Sligo is only eighteen miles; from whence I apprehend they may be conveyed to most ports in Ireland as cheap as they can from the works in Scotland. But for the certainty

thereof I must leave those to judge, who are better acquainted with the situation of the place. Admitting this correct, and the two furnaces were to make sixty tons per week, for fifty-two weeks would be 3120 tons. The profits arising from the works, if the whole were sold in pigs, would be as follows:

Say one half was inferior iron, then there would be

	£	s.
1560 tons of best grey, at 8 <i>l</i> . 5 <i>s</i> . per ton,	12870	0
1560 do. of inferior, at the medium between the two sorts, 6 <i>l</i> . 15 <i>s</i> . per ton,	10530	0
	23400	0
Making 3120 tons, at 4 <i>l</i> . 15 <i>s</i> . per ton,	£14820	
Carriage of the above to Sligo, at 15 <i>s</i> . per	2340	
	17160	0
	6240	0
If there could be 4 tons per week sold in castings, you would have to add a profit of 5 <i>l</i> . per ton on 208 tons of castings,	1040	0
Which would make a yearly profit of	7280	0

If the iron were not to be sold in pigs, then you would have to say that 3120 tons of pig iron will produce 1806 tons of bar iron at the rate of 35 cwt. of pigs to make a ton of bars, agreeable to the before-mentioned estimates.

Then 1806 tons of bar iron sold at the works at

17 <i>l</i> . 5 <i>s</i> . (This is the price as reduced by Messrs. Blair and Co.) but at the towns on the road between Dublin and Arigna the smiths pay 24 <i>l</i> . per ton,	31153	10
Making 1806 tons of bars, at 13 <i>l</i> . 8 <i>s</i> . per ton,	24200	8
Brought over	6953	2

	£.	s.
Carried forward	6953	2
A part of this may be rolled into bolts and five-eighths squares ; you will therefore have to add 2l. per more for the quantity of iron, which may be made of these sizes, say 70 tons at 40s.	140	0
	7093	2

If the iron will answer for hoops, I presume a large quantity may be sold. The present prices of these are 28l. per ton, and it was till lately sold at 38l. per ton by the ironmongers in Dublin. Say the rolling into hoops cost 5l. per ton more than bars ; the difference between the price of making and the reduced price they are now for would be 9l. 12s. per ton.

(These calculations, as far as respect the manufacturing, are made according to the price of labour given in this country. Therefore so much as the price of labour can be reduced at Arigna, it will increase the profits.)

If the sudden fall of bars, which had taken place by Messrs. Blair and Co. should not be likely to continue, then the extra price, which it can be sold for, will be to be added to the calculations, viz.

Suppose bar iron to be sold at the works at 20l. per ton, the usual price it is sold at in Dublin, then the profit on 1806 tons at 6l. 12s. per ton will be

11919 12

THOMAS GUEST,
Dowlais Iron Works,
Glanmorganshire.

March 1st, 1805.

APPENDIX, No. III.

GLOSSARY.

IT has frequently been objected to works of science, that the generality of readers are supposed to possess a certain portion of knowledge, particularly of the first principles and technical terms, which are by much the most difficult to acquire, and of which, in most cases, they are perfectly ignorant.

As this work is intended to instruct persons unacquainted with the sciences of Mineralogy and Geology, technical terms have been avoided, as far as was consistent with clearness and brevity of description; still many have necessarily been inserted. To explain them the following Glossary has been formed, which it is hoped will prove useful and satisfactory to general readers.

ARCHITE.—A fossil bivalve shell, with equal valves; the name is derived from the peculiar form of the joint, which presents a hollow somewhat resembling the interior of a boat.

BEDS.—The rocks, that occur near the surface of the earth, are usually divided into parallel layers, which are easily separable from each other; the substance of each layer being perfectly distinct, and frequently composed of a different substance from those, which lie either above or below it; these layers are called beds. Thus a layer or bed of coal usually rests on a bed of fire clay, and is covered by a bed of sandstone or slate clay.

CHAMITE.—A fossil bivalve shell: it occurs petrified in great abundance in the great limestone district of Ireland.

CALCAREOUS SPAR—or spar of lime, is lime in a crystalline form; this substance is composed of nearly equal portions of pure limestone and carbonic acid.

CLAY SLATE—Is a simple rock of the primary class, usually of a greyish blue colour; it is easily divisible into thin flakes; with the finer varieties of it the roofs of our houses are covered.

COPPER PYRITES—is the metal of copper combined with sulphur; it usually exhibits a bright yellow colour, and strong metallic lustre.

CROP OR OUTGOING—is that part of a bed of coal or other substance, which appears at the surface.

CRYSTALLINE STRUCTURE.—When a rock is composed of an aggregation of crystals, either of the same or different mineral substances, it is said to have a crystalline structure.

DIP.—The beds or layers of rocks, that occur near the surface of the earth, are rarely found either in a true horizontal or vertical position. They usually incline more or less from the horizon. This inclination is called the dip. If the inclination be towards the north, it is called a north dip; if to the south, a south dip, &c.

FAULT.—Fault is a general term given by coal miners to any irregularity, that is observed in the strata.

Faults may be divided into two classes, slips, and undulations in the strata.

Slips are those disturbances, which have apparently taken place by the slipping or falling down of one part of the strata to a lower level, leaving the other in its original position. The quantity of the depression varies from a few inches to many hundred feet.

Undulation.—When the strata, from being perfectly regular, and dipping to the south or any other part of the compass, suddenly change their inclination and rise in an opposite direction, and again as suddenly descend, and continue in their first inclination, they are said to undulate.

FELD SPAR.—Feld spar is a simple mineral substance of a white or greyish white colour; its fracture is foliated in every direction, and it breaks into rhomboidal fragments. Feld spar is one of the essential components of granite.

FLOETZ—means flat or horizontal; this name has been given to the class called secondary rocks, from their being generally found in a flat or horizontal position.

The celebrated Professor Werner of Freyberg, and his pupils, have classed the rocks, which compose the surface of the earth, into three principal divisions, which have been named primitive transition, and secondary, or floetz. Primitive rocks are stratified vertically, or approaching to vertical; their average inclination may be about sixty degrees from the horizon. Their internal structure is for the most part crystalline, and they rarely, and until lately were never known to contain any mechanically formed deposits.

The stratification of transition rocks resembles that of the primitive, upon which they rest. They contain not only mechanically formed deposits, as solid fragments; but organic remains of marine shells are sometimes found in rocks belonging to this class.

Transition rocks are intermediate between primitive and secondary, and they partake of the characters of both. The name was given by Professor Werner, who supposes them to have been formed during the passage and transition from its chaotic to its habitable state; but from its theoretical origin this appellation has been much objected to.

Secondary, or floetz rocks, are for the most part stratified horizontally, and they rarely exceed an angle of 45 degrees from the horizon; they rest upon transition rocks, and, when this class is wanting, which frequently happens, they rest upon primitive rocks.

Secondary or floetz rocks are chiefly composed of mechanically formed deposits.

FIRST FLOETZ SANDSTONE.—This rock is considered the oldest, that is, the first deposit of the secondary or horizontally stratified class.

FIRST FLOETZ LIMESTONE—rests upon the first floetz sandstone; it is considered the first or oldest rock of the secondary limestone species.

GNEISS.—The second rock of the primary class; its component parts are similar to granite; the difference between them consists in the arrangement of the mica in a particular direction, which is not the case in granite.

GRANITE—is a rock composed of an aggregation of crystals of three simple minerals, quartz, feldspar, and mica; it is one of the primary rocks, and, from its being generally found beneath all others, it is classed as the first of the primary rocks.

GRAYWACKE—is a rock composed of an aggregation of grains, or rounded fragments generally of quartz, cemented by a paste of clay slate; it is the principal member of the transition class of rocks. The name is derived from a German word signifying rubblestone.

HORNBLENDE ROCK—is a greenish or blackish green rock, composed of an aggregation of crystals of the mineral called hornblende.

HORNBLENDE SLATE—is similar in composition to hornblende rock, but the crystals are smaller; the structure is slaty.

HURRYING ROADS—are passages left in a colliery, through which coals are drawn to the bottom of the coal pit.

INFLAMMABLE COAL—is distinguished from carbonaceous or non-flaming coal by its blazing quality; it is composed of carbon or charcoal and bitumen.

IN SITU—in its native bed.

LYDIAN STONE—is a black, and sometimes greyish mineral, of the nature of flint; it is frequently found in rounded nodules, and sometimes in irregular beds, interstratified with the first floetz limestone. This substance is frequently called basanite and touchstone.

MADREPORE—is a petrification of the coralline species; it occurs in great abundance in limestone rocks.

MICA—is a simple mineral of the argillaceous genus; it exhibits a strong metallic lustre, and is easily separable into

thin elastic plates. The name is derived from the Latin word *micare*, to shine.

MICA SLATE—is a stratified schistose rock of the primary class; it is composed of quartz and mica.

NON-FLAMING COAL—is a simple mineral substance, composed of from 90 to 96 per cent. of pure carbon or charcoal, and from 4 to 10 per cent. of ashes; it is distinguished from inflammable coal by its containing no bitumen; it burns without flame or smoke.

OUTGOING.—See Crop.

PRIMARY ROCKS.—See Floetz.

QUARTZ—is a simple mineral of the siliceous genus; it is found crystallized in the form of a six-sided prism, terminated by a six-sided pyramid at both ends, corresponding with the planes of the prism; but it is rare to find more than the prism and one pyramid perfect.

QUARTZ ROCK—is a rock of the primary class, composed of an aggregation of grains or imperfect crystals of quartz.

ROCK CRYSTAL—is a transparent variety of quartz. The composition and crystallization are similar.

SANDSTONE—is a rock composed of a granular aggregation of particles, or rounded fragments of quartz or siliceous sand, cemented by a calcareous, argillaceous, or ferruginous paste.

SANDSTONE SLATE—is a rock, which frequently occurs in the coal formation, interstratified with sandstone and slate clay; it partakes of the character of both those rocks.

SERPENTINE—is a simple rock of the magnesian genus and primary class. The name is derived from its varied hues, and the silky and serpentine appearance of the asbestos veins, by which it is frequently traversed.

SLATE CLAY—is a rock belonging to the secondary or floetz class; it occurs in great abundance in the coal formation; it is usually of a bluish black colour, which graduates into grey. By exposure to the atmosphere it quickly disintegrates, and becomes a tenacious clay.

SLIP.—See Fault.

STEATITE—is a simple mineral substance of the magnesian genus; it is easily distinguished by its soapy feel; when free from iron, this substance is of great value as an ingredient in the manufacture of porcelain.

STRATIFICATION.—See Beds.

SULPHUR PYRITES—is a simple mineral substance of a bright yellowish white colour, and strong metallic lustre; it is composed of sulphur and iron.

SULPHURET OF LEAD—or common galena, is a mineral substance composed of lead combined with sulphur. Lead ore, as it occurs in mines, is usually found in this state.

SYENITE—is a rock of the primary class, composed of feldspar and hornblende; the name is derived from the town of Siena, at the cataracts of the Nile, where this rock occurs in great abundance.

TRANSITION ROCKS.—See Floetz.

UNDULATION.—See Fault.

VEIN—among miners is the mineral repository, in which the ore of any metal is found; but veins are sometimes composed of rock, and contain no metallic substance.

FINIS.



lor 19 North strand
late of Bagot St



Griffith, Richard J.

Geological and mining Survey of the Connaught coal district in Ireland

Dublin 1818

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